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THE BOEING COMPANY

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TITLE ANALYSIS - EFFECT OF DEPTH INCREASE, LAUNCH TUBE, WING V

MODEL NO. WS-133A CONTRACT NO. AF04(647)-289

ISSUE NO. 10 ISSUED TO ASTIA

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LIST OF REFERENCES

D2-4979 — Volume I, "Silo Launch Verification - Gas Dynamic Stability Characteristics - WS-133A - Minuteman", to be revised 15 July 1963

D2-4979 — Volume II, "Silo Launch Verification - Missile Clearance - WS-133A Minuteman" to be revised 1 September 1963

D2-11136 — Volume III, "Wing VI Launch Pressure Environment"

D2-11137 — Volume IV, "Wing VI Launch Thermal Environment"

D2-11730 — "Dynamic Analysis of Wing II Minuteman Missile Launcher Mount - Figure A 1322" (Revision A)

1.0 PURPOSE AND SCOPE

This document presents the results of evaluation of Weapon System compatibility with the 10 foot deeper launch tube at Wing V. Included are data reflecting missile launch performance, launcher configuration, maintenance requirements, and human factor considerations. Wing V launchers are designed; therefore, this document covers only those studies and mandatory hardware changes necessary to accomodate the 10 foot increase in depth of the launch tube.

It should be noted that this document merely summarizes the effects of the deeper launcher. In many instances, substantiating data will be found in the established Wing V documentation. In particular, reference must be made to missile performance and dynamic study documents (noted in paragraphs 3.0 and 5.0 and listed in the list of references) and, in Paragraph 2.2.2, to the Engineering Change Proposals for complete substantiating data.

2.0 STUDY PARAMETERS AND SUMMARY

2.1 BACKGROUND

2.1.1 This study has been conducted in accordance with STL Document 6660.42-31 dated 3 January 1963. The study evaluates the Weapon System for compatibility with the Wing V Launch tube which is 10 feet deeper than those in Wing I to IV. Authorization for this study was given by CCP 815, CCN 816 (BSD-63-MSN-6004).

2.1.2 The vertical location of the missile in the deeper tube will be identical to that of the Wing I through IV configuration. Refer to Figure 4.1 and 4.2 (Page 13 and 14).

2.1.3 The missile will be the Wing II configuration.

2.1.4 Only the Weapon System changes made mandatory by the deeper launch tube are considered in this study. No other proposed Wing V changes were considered.

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2.1.5 Three areas of Weapon System effects were evaluated: Effect on missile performance, effect on system hardware and mandatory changes, and man - machine relationships.

2.2 STUDY RESULTS SUMMARY

2.2.1 It is predicted that Missile performance, including dynamics and fly-out trajectories, is not adversly affected by the Wing V silo.

2.2.2 The following hardware changes are required:

FIGURE A	NOMENCLATURE	CHANGE
1248	Cable Set, Launcher	ECP 518
1322	Missile Suspension System	ECP 559
4043	Elevator Work Cage	ECP 539 R1
ACO 215	Hole Locating Fixture	ECP 559
ACO 216	Leading Fixture	ECP 559

2.2.3 No human-factors problems are evident.

2.2.4 System verification testing is required at VAFB.

3.0 MISSILE PERFORMANCE

3.1 GAS DYNAMIC STABILITY CHARACTERISTICS

3.1.1 Cold flow testing was not conducted. Existing cold flow data from Wing II and Wing VI tests will be analyzed so that Wing V gas dynamic stability characteristics may be defined.

3.1.2 The data will be published by July 15, 1963 and will appear as a revision to D2-4979, Volume I "Silo Launch Verification - Gas Dynamic Stability Characteristics - WS-133A - Minuteman".

3.2 FLY-OUT TRAJECTORY AND CLEARANCE

3.2.1 The missile fly-out trajectory and the nozzle/mount relative motion will be studied using the gas dynamic characteristics developed as noted in paragraph 3.1 (above).

3.2.2 Design clearance envelopes will be defined.

3.2.3 The data will be published by September 1, 1963 and will appear as a revision to D2-4979, Volume II "Silo Launch Verification - Missile Clearance - WS-133A - Minuteman".

3.2.4 No fly-out clearance problems are expected. This conclusion is based on analyses conducted to date on the Wing I and Wing II missile launches. The deeper launcher should reduce the magnitude of gas dynamic forces and moments acting on the missile. This should make the skirt/silo clearance greater than the Wing I or Wing II launches. Definition of the actual Wing V launch trajectory will be provided, however, to verify that there is no clearance problem.

3.3 THERMAL AND PRESSURE ENVIRONMENT

Review of the in-silo pressure and thermal environment showed that deepening the launcher reduced both blast wave overpressure and missile heating rates. No pressure or thermal environmental problems will result from a 10 feet deeper launch tube with the missile remaining at the same level relative to the top of the launch tube.

These conclusions are based on studies made of Wing VI missile retrofit into Wing II launchers. D2-11137 Volume IV, "Wing VI Thermal Environment" and D2-11138 Volume III, "Wing VI Pressure Environment" show a more severe environment exists with a Wing VI missile in a Wing II launcher than in a Wing VI launcher (which is the same depth as Wing V launcher). Refer to Figure 4.1.

4.0 LF (RPIE) EFFECTS

4.1 Wing V RPIE and LF Facilities were investigated for functional compatibility with the Weapon System. It should be emphasized that Wing I - IV RPIE is not required to be used at Wing V but rather Wing V RPIE requirements are set forth as a separate entity to satisfy a new facility configuration.

4.2 Launch Tube requirements are defined by the "Facilities Design Criteria".

4.2.1 RPIE, Material, and Construction Specifications and details are defined by the BSD/AE plans and specifications.

4.2.2 Boeing had reviewed the A/E drawings for hardware and interface compatibility prior to construction contract award. Wing V facilities design was concurred with and recommendations given.

4.3 Specific areas of concern in regard to the affects of the 10 foot deeper launcher are as follows:

4.3.1 Environmental Control System (ECS)

(a) Launch Tube heating requirements are a function of ground temperature and tube area. Ground temperature varies with depth and season, but is essentially equal to well water temperature in the site area and stablizes at about 30 feet. Malmstrom AFB ground temperature is about 42° to 43° F. Warren AFB ground temperature is about 47° F. (from ASHRE Guide, 1952). Thus, although Wing V launchers have approximately 380 square feet more heat transfer area than Wing I launchers, the total heat loss of the two launchers is comparable.

(b) The 4.5 KW launch tube heater will be adequate at Wing V as at previous Wings. The ten foot additional length of the air duct would have less than a 1% reduction affect on air flow and net heat input.

(c) Although the deeper launcher does not materially affect the heat and power leads associated with the LF ECS, the proposed ECS (Figure A 1211.3) for Wing V appears deficient in certain other aspects. These deficiencies are presently being

investigated. They are not analyzed here because the same problems are as applicable to Wings III and IV as they are to Wing V.

4.3.2 Sump Pump

(a) The static head due to the increased depth on sump pump (SP-102) is 10 feet greater at Wing V compared to Wing IV. The friction head due to flow through the 10 foot longer discharge line is one half foot greater. Therefore, the total discharge head on the pump at the same flow is increased 10.5 feet.

(b) Parsons drawings P-1 for both Wing IV and Wing V call for a pump capable of discharging 20 gpm against a total discharge head of 105 feet. The requirement cannot be the same at both wings.

(c) The Corps contractor's shop drawings show the same pump at both wings in accordance with the Parsons requirements.

(d) Calculations by Boeing estimate the total discharge head requirement at Wing V to be 104.5 feet and at Wing IV 93.0 feet.

(e) Conclusion: The specified sump pump is satifactory at Wing V. It is noted that the pump delivery at Wing IV will be approximately 35 gpm.

4.3.3 Missile Suspension System Interface

(a) Provisions have been provided in Wing V LF for proper attachment of the suspension system.

(b) Refer to paragraph 5.1.4 for OGE analysis.

4.3.4 Security Motion Transducer

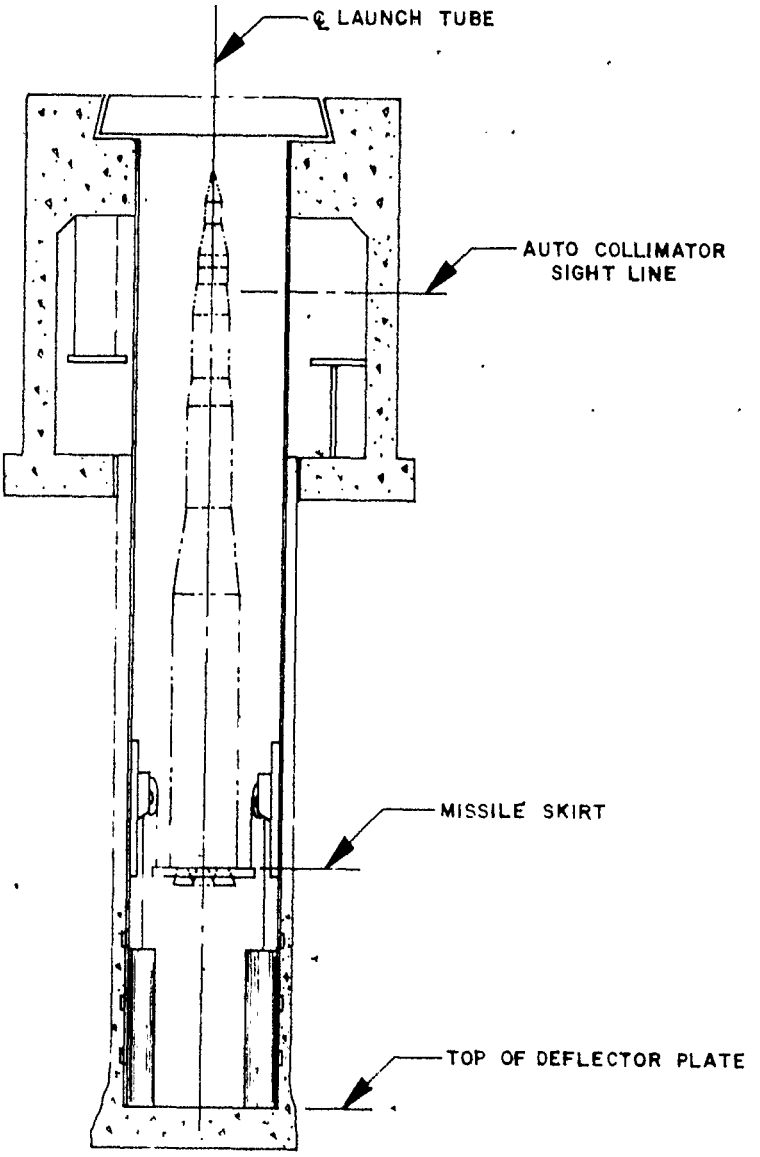
(a) The vibration sensor Junction Boxes are located in the same relative position as required in Wings I through IV. This places them 10 feet higher relative to the bottom of the silo. Reference: A & E drawings and ICD 25-35211.

(b) This location appears to be satisfactory. Penetration into the launch tube at the lowest 10 feet is unlikely. Also, the sensors are extremely sensitive (enough to preclude unauthorized entry at this depth).

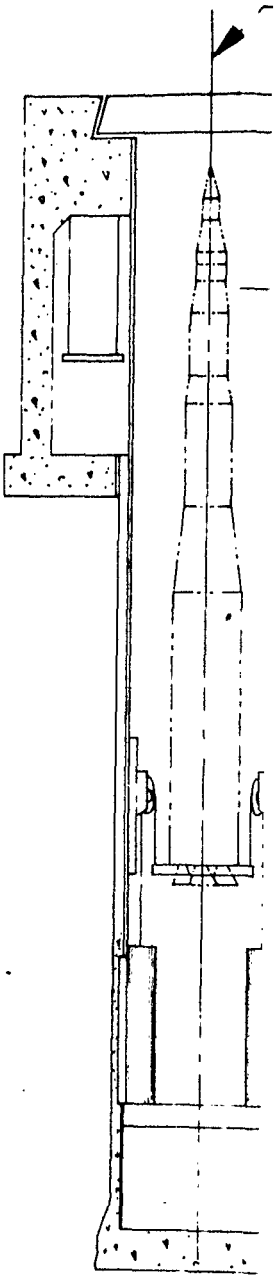
4.3.5 Missile Base Ground Tie Box

This box is correctly located relative to the missile mounting ring.

4.4 See Figure 4.1 and 4.2 for a pictorial comparison of VAFB and operational launchers.

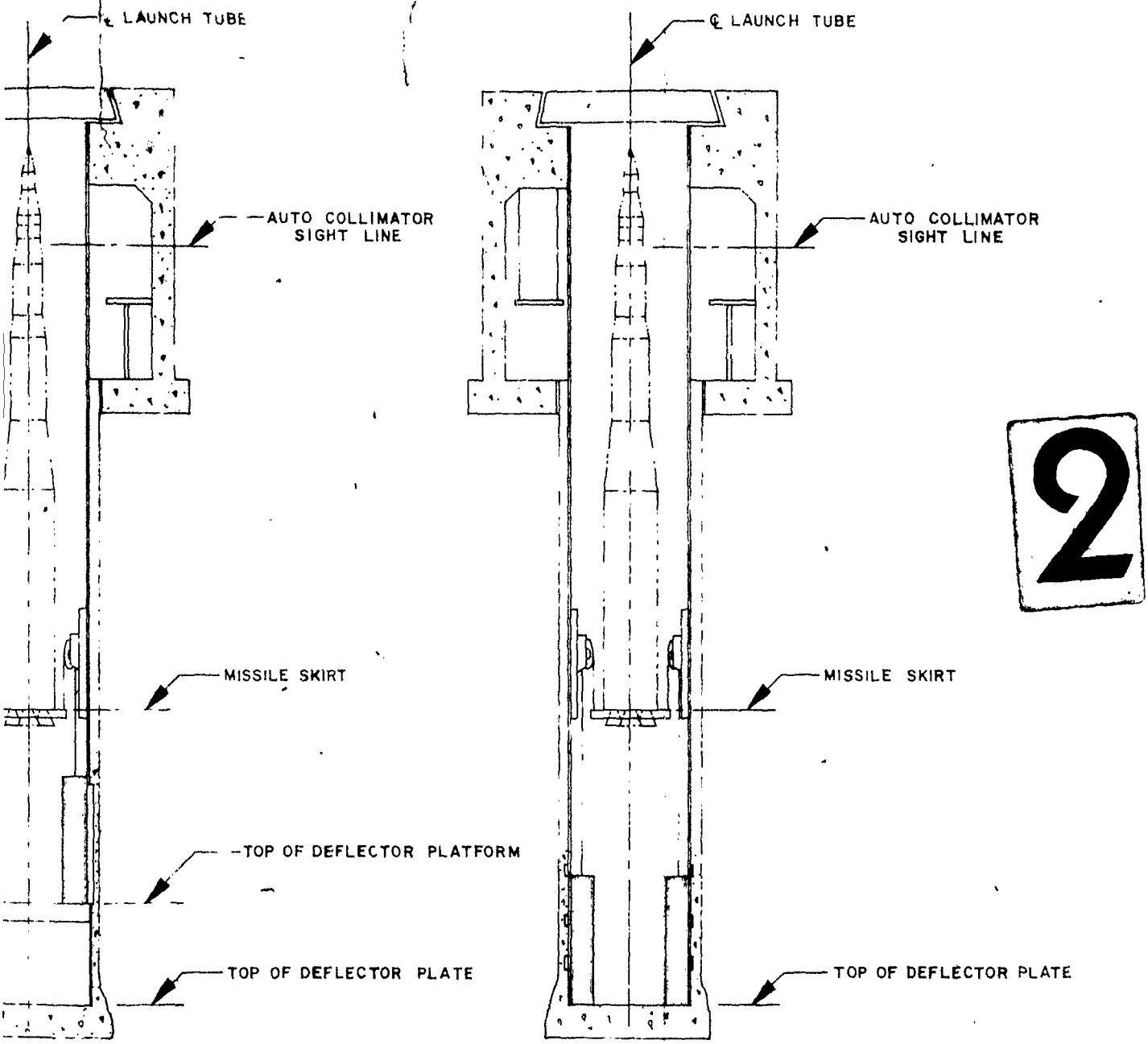


VAFB LF #6
WINGS II THRU IV CONFIGURATION



VAFB LF #
WING III CONFIGU

1

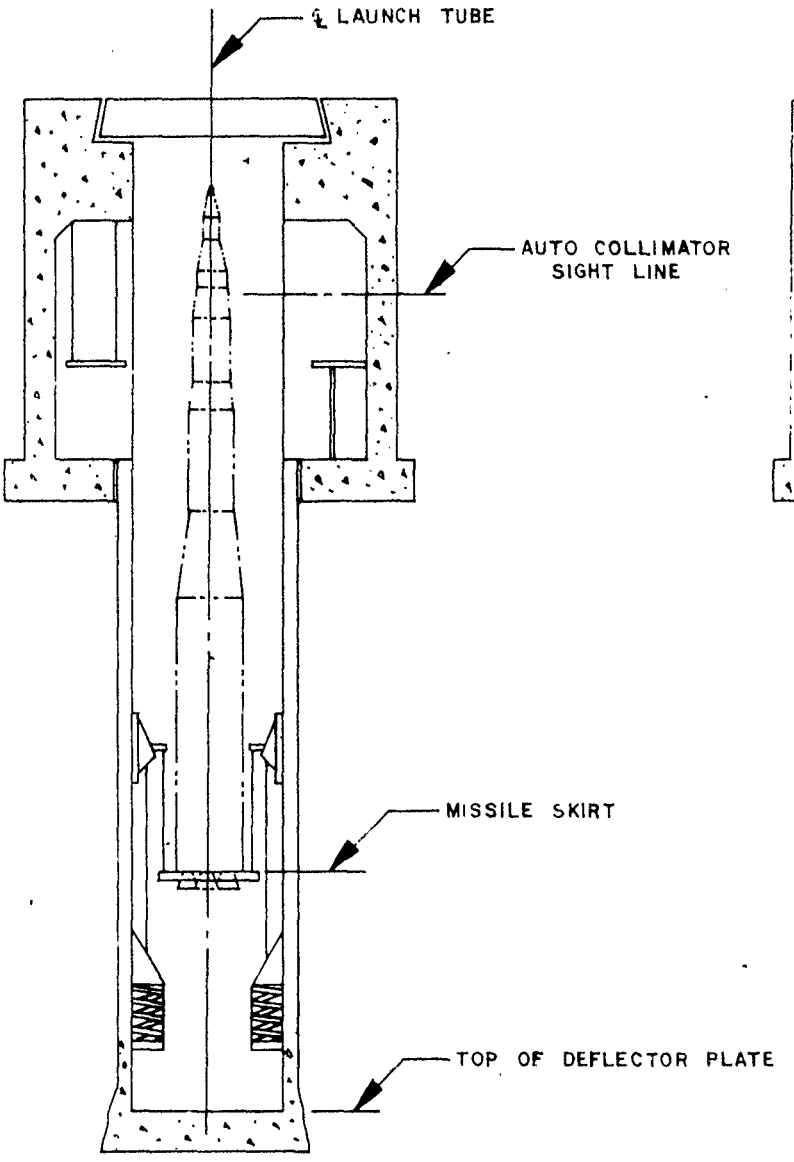


2

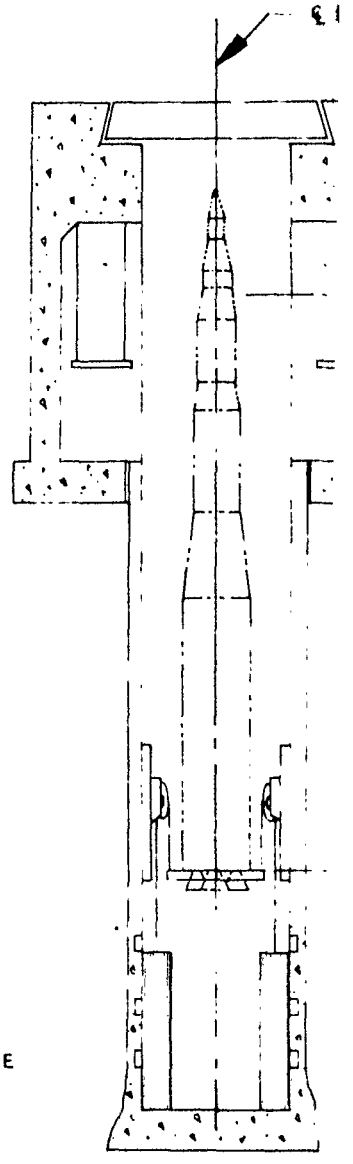
B LF #7
CONFIGURATION

VAFB LF #8 (PROPOSED)
WING V CONFIGURATION
(SIMILAR TO WING VI SILO)

FIG 4.1 - VAFB LAUNCHER PICTORIAL COMPARISON



WING I



WINGS II THRU

1

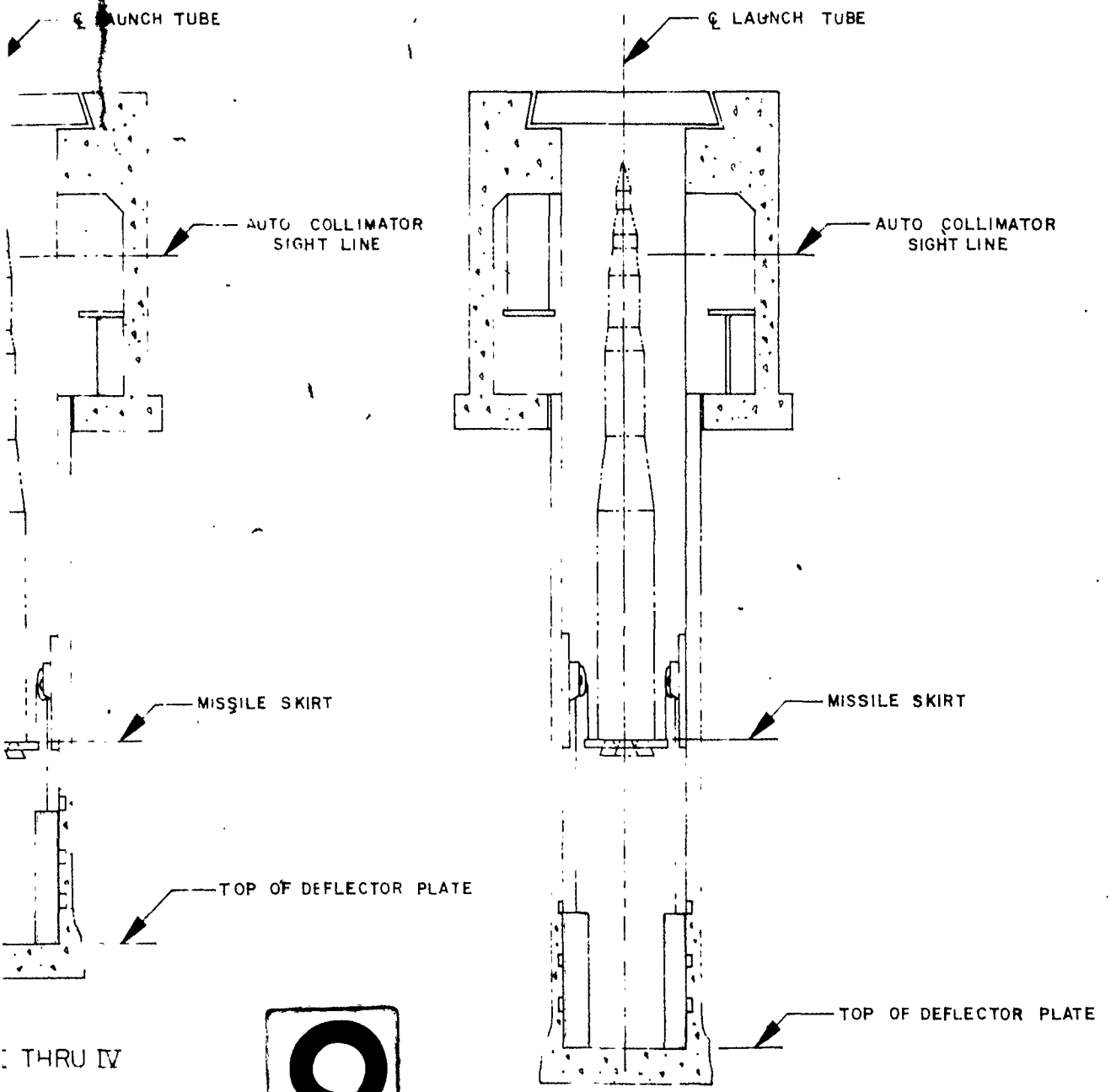


FIG 4.2 - OPERATIONAL LAUNCHER PICTORIAL COMPARISON

5.0 OGE EFFECTS

5.1 FIGURE A 1322 - MISSILE SUSPENSION SYSTEM

5.1.1 Length of tether cables and suspension cables must be increased by 10 feet to allow for 10 foot deeper launcher.

5.1.2 Effect on vertical spring rate, and tether spring rate (due to cable length change) is negligible. No changes are required to the tether springs, suspension springs, nor the torsion bars. The tether and suspension cable diameters will not be changed.

5.1.3 The dynamic analysis for the missile suspension system may be found in D2-14730 "Dynamic Analysis of Wing II Minuteman Missile Launcher Mount - Figure A 1322" (Secret). It will be seen from this analysis that there are no problems with the redesigned system in the Wing V launcher.

5.1.4 ECP 559 has been established to procure hardware to the new Figure A (1322.5) for Wing V.

5.2 FIGURE A 1248 - CABLE SET, LAUNCHER

5.2.1 Only one cable, W720, is affected by the deeper launch tube. W720 is a telephone communication cable running between Unit No. 428 and Unit No. 426.

5.2.2 The cable will be revised under ECP 518, "Redesign of intrasite cable system for facility difference at Wing V".

5.3 No other item of OGE is affected by the 10 foot increase in launcher depth.

6.0 MGE EFFECTS

6.1 FIGURE A 4043 - ELEVATOR WORK CAGE

6.1.1 Use of the Elevator-Work Cage in the ten foot deeper launcher of Wing V is limited by the length of the two cables: (1) The Power and Communication Cable and (2) the Hoist Cable

6.1.1.1 Figure 6.1 and 6.2 show the limiting factors to be as follows:

Power and Communication Cable

(a) With the present routing of the Power and Communication Cable, the Work Cage would be one foot 11½ inches short of reaching the nominal launcher depth (see Figure 6.1).

NOTE: Nominal dimensions of the launcher from A & E drawings as shown in Figure 6.2.

(b) By rerouting the cable inside the Work Cage, the cage could descend a maximum of one-half inch beyond the nominal launcher depth.

Hoist Cable

(a) The hoist cable allows the bottom of the Work Cage to reach 11 inches beyond the nominal launcher depth (see Figure 6.2)

(b) Fully extended, the bearing point of the hoist hook will reach 5 feet 5½ inches short of the nominal bottom of the launcher.

6.1.1.2 From meager available data, Liaison has provided field measurements showing the following:

Whiteman launch tube depth 1.58 inches greater than nominal.

Ellsworth launch tube depth in excess of 1.25 inches greater than nominal.

This information indicates that the launchers may not be more than an inch or two deeper than nominal.

6.1.2 The Power and Communication Cable must be rerouted to allow the Elevator-Work Cage to reach nominal bottom in the ten foot deeper launch tube. Since there is only about one-half inch to spare and extra length should be supplied for cut-off when connector ends are repaired, it is recommended that the cable length be increased by adding approximately seven foot extension to be permanently installed in the Work Cage.

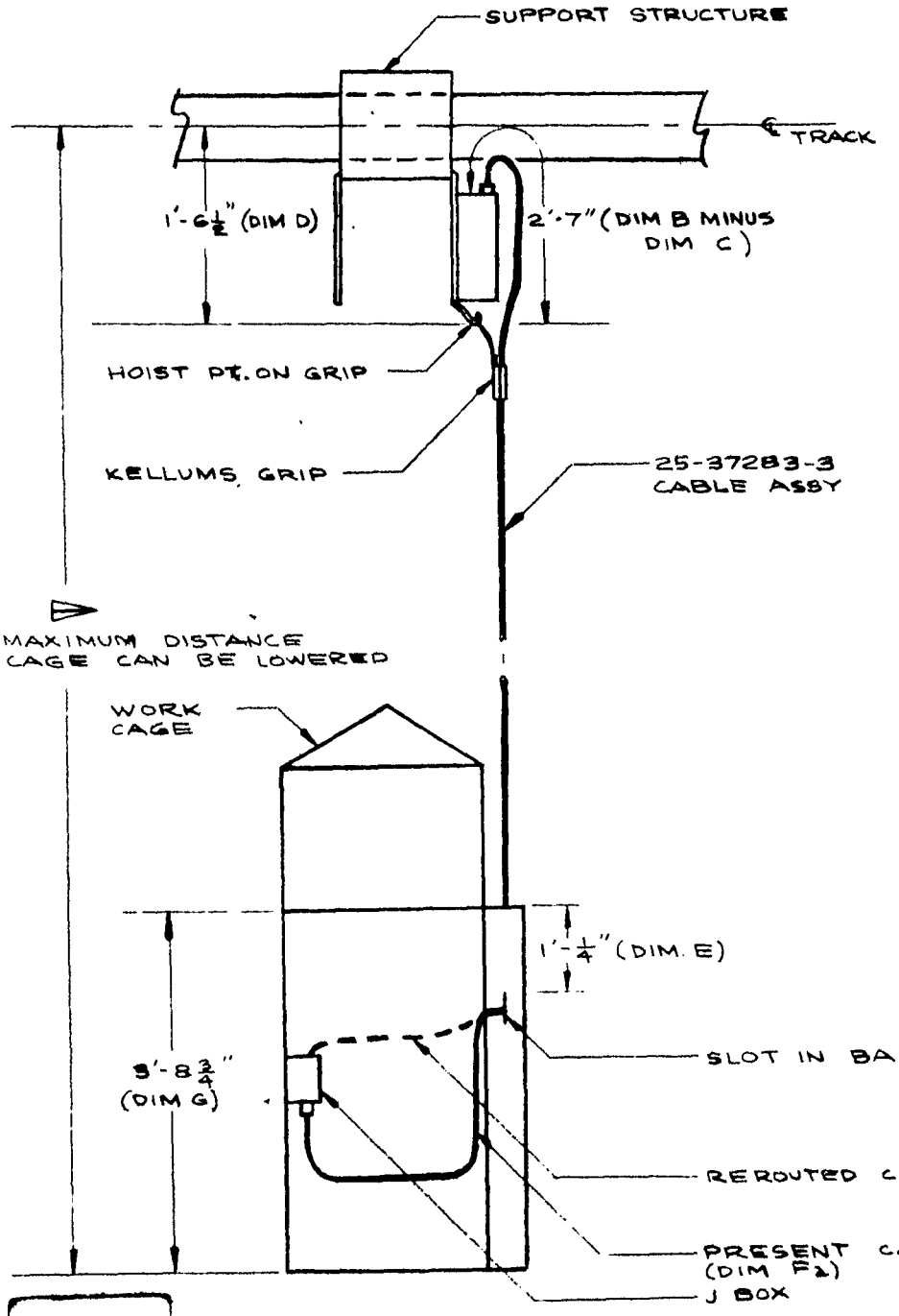
6.1.3 In addition to hoisting workmen and tools, the Elevator Work Cage is used as a hoist during maintenance of the sump pump located in the bottom of the launcher. This is in accordance with procedures set up by Form "C" No. 1209 (D2-6951 Volume IV G).

6.1.3.1 A one-half inch hemp rope is to be used to secure the hoisted part to the Elevator Work Cage. This provides flexibility in reaching the sump pump from the hook on the work cage hoist line, which is five to six feet above the bottom of the launcher.

6.1.3.2 Replacement of the present Elevator Work Cage hoist cable for these stated uses is not recommended as being required for use in the Wing V launcher.

6.1.4 It should be noted ECP 539R-1 is being submitted and ten feet additional cable is being proposed in accordance with Air Force request. If ECP 539R-1 is incorporated, there will be no requirement to extend the capabilities of the Elevator-Work Cage under CCP 815.

6.2 NO OTHER ITEMS OF MGE ARE AFFECTED.



1

WORK CAGE / POWER & CONTROL CA

DIMENSION TABLE

DIM	DESCRIPTION	VALUE
A	MIN LENGTH OF CABLE 25-37283-3 PER ADCN 6 TO 25-37283	83'-0"
B	FROM END OF CONNECTOR TO BOTTOM END OF KELLUMS GRIP (P/N SD-9)	3'-8"
C	BOTTOM END TO HOIST PT ON SD-9 GRIP (FROM KELLUMS GRIP CATALOG)	1'-1"
D	FROM ℄ TRACK TO BEARING POINT OF HOOK SUPPORTING GRIP (PER GS40830 SHT2)	1'-6½"
E	TOP OF BAG TO TOP OF SLOT IN BAG (PER ADCN 6 TO 25-37263)	1'-¼"
F	CABLE FROM SLOT IN BAG TO J BOX	
	a - PRESENT (PER ▷ ON 25-18099)	6'10"
	b - REROUTED	4'10"
G	TOP OF BAG TO BOTTOM OF CAGE (PER 25-18605)	3'8¾"

2

▷ MAX. WORK CAGE LOWERING ALLOWED BY POWER & CONTROL CABLE

1. PRESENT CABLE ROUTING:
   = DIM A - [E + F$_a$ + (B-C)] + D + G
   = 77 FEET - 10 INCHES

2. POSSIBLE BY REROUTING CABLE WITHIN CAGE:
   = DIM A - [E + F$_b$ + (B-C)] + D + G
   = 79 FEET - 10 INCHES

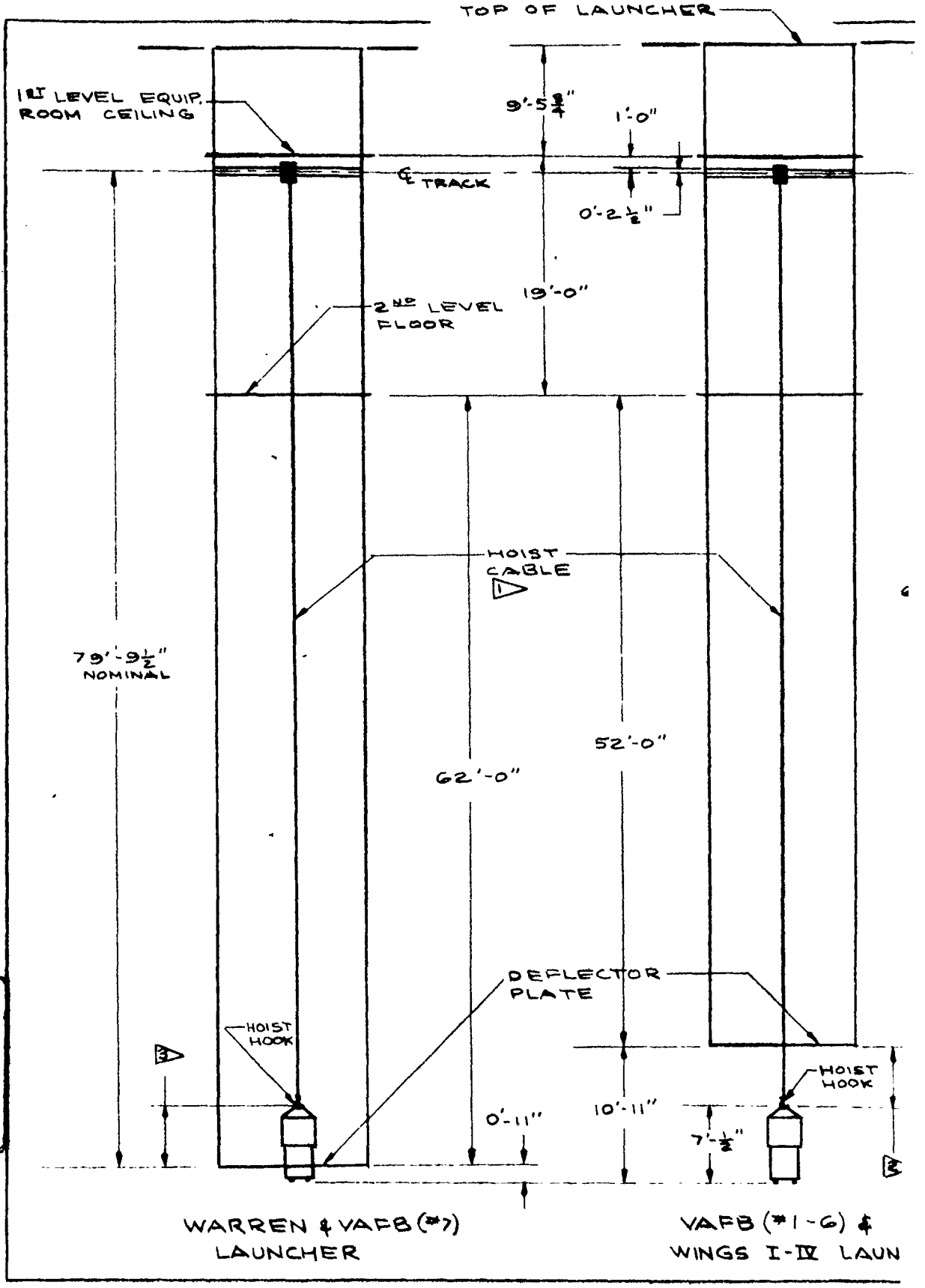
(REF: LAUNCHER NOMINAL DEPTH WING V 79 FEET - 9½ INCHES

1 F$_b$)

OUTING

CABLE LIMITATIONS

FIGURE 6.1


TOP OF LAUNCHER
1ST LEVEL EQUIP. ROOM CEILING
9'-5 3/4"
1'-0"
℄ TRACK
0'-2 1/2"
19'-0"
2ND LEVEL FLOOR
HOIST CABLE
1
79'-9 1/2" NOMINAL
52'-0"
62'-0"
DEFLECTOR PLATE
HOIST HOOK
3
0'-11"
10'-11"
HOIST HOOK
7'-1/2"
3
WARREN & VAFB (#7) LAUNCHER
VAFB (#1-6) & WINGS I-IV LAUN

1

NOTES

1. LAUNCHER DIMENSIONS FROM A&E DRAWINGS: MALMSTROM - SHT S-19 & S-32; ELLSWORTH, MINOT, & WHITEMAN - SHT S-19 & S-39; VAFB - SHT S-20 & S-34; & WARREN - SHT S-19 & S-39.

2. ALL LF DIMENSIONS ARE NOMINAL. FIELD CHECK SHOWS THAT IRI LEVEL EQUIP ROOM CEILING TO BOTTOM OF LAUNCHER WAS 1.58 INCHES GREATER THAN NOMINAL AT WHITEMAN AND 1.25 INCHES GREATER THAN NOMINAL AT ELLSWORTH

3. THE HOIST HOOK WILL REACH TO THE BOTTOM OF THE LAUNCHER AT WINGS I-IV AND MIGHT BE USED FOR LIFTING ITEMS OTHER THAN THE WORK CAGE. THE HOOK WILL BE 5'-5½" SHORT OF LAUNCHER BOTTOM AT WING V

69'-9½" NOMINAL

HOIST HOOK

(1) 73'-8" PER C-20862 PARAGRAPH 3.1.6.C

(2) BEARING POINT OF HOOK CAN EXTEND 3'-10⅓" BEYOND NOMINAL DEPTH OF LAUNCHER WHEN LOWER LIMIT SWITCH IS ACTUATED

(3) BEARING POINT OF HOOK WILL BE 5'-5½" FROM NOMINAL DEPTH OF LAUNCHER WHEN LOWER LIMIT SWITCH IS ACTUATED

6) & LAUNCHER

2

FIGURE 6.2 - WORK CAGE / HOIST LIMITATIONS

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7.0 HUMAN ENGINEERING

7.1 Detailed task analyses were performed on the following functions to determine if any human engineering problems were created by the 10-foot extension of the launch tube.

A. Missile Base Support Leveling

B. Dead Band Leveling Missile Base Support

C. Sump Pump Installation, Removal & Maintenance

D. Work Cage Utilization

E. Installation and Maintenance of the SIN Inter-Communications J-Box

F. Installation and Maintenance of the Motion Sensing Transducers

G. Missile Installation and Removal

7.2 The analyses (Fig. 7.1 through 7.7) indicate that no significant human engineering problems are created by the launch tube extension.

7.3 An increased utilization of the elevator work cage is predicated on the basis of using it to perform skirt umbilical remove and replace functions for which a step ladder is now employed. The additional 10 feet will make the use of a stepladder unrealistic.

FUNCTION: A MISSILE BASE SUPPORT LEVELING	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS
1) Three members assemble work cage*		
2) Place vapor-proof flood lamps in work area on second level and secure to provide light in lower launch tube area.	Vision, hearing, touch. Illumination such that glare is reduced by lamp adjustment at 2nd level.	Number of lig required, what wattage, i.e., 75 to 300 wat available.
3) Enter elevator work cage and descend to missile base.*		
4) Verify that first stage missile skirt grounding strap, located near skirt umbilical restraint bracket is connected to missile support ring adapter.	Vision, touch.	Whether prope connection is made.
5) Verify that ground cable is connected between ground strap located on outside of missile support ring adapter and one of the cable connector lugs in missile base ground point junction box.	Vision, touch. Are junction box connector lugs free of corrosion.	Is a proper earth ground established.
6) Using first stage skirt restraint clamp bolt holes, install missile base support level set on missile support ring adapter so that levels are oriented to one of three leveling jacks.	Vision, touch	Which levelir jack to orier to - jack 1, or 3.

1

*See detailed Task Analysis for work cage, page 33

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH A 10 FOOT DEEPER SILO - WING V

PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERRORS
Vision, hearing, touch. Illumination such that glare is reduced by lamp adjustment at 2nd level.	Number of lights required, what wattage, i.e., 75 to 300 watts available.	Attach lights by screwing and adjusting clamp.	Voice communication between operators. No visual links in this location.	Safety lanyards attached when working in silo on work cage and attaching lights.	Misjudging light ment for glare-fr illumination at s bottom.
Vision, touch.	Whether proper connection is made.		Voice		Insecure ground attachment.
Vision, touch. Are junction box connector lugs free of corrosion.	Is a proper earth ground established.	Make earth ground attachment.	Voice		Insecure ground attachment.
Vision, touch	Which leveling jack to orient to - jack 1, 2 or 3.	Tighten thumb screws provided with level set.	No specific communications requirement. One member operation.	Safety lanyard must be connected to ring of work cage.	None likely.

2 DATA SHEET

SAFETY QUIREMENTS	PROBABLE ERRORS	JOB AIDS OR TOOLS	NORMAL SILO	VS	DEEPER SILO WING V
lanyards d when work- silo on work d attaching	Misjudging light placement for glare-free illumination at silo bottom.				Possibility of increased light wattage.
	Insecure ground attachment.				Same
	Insecure ground attachment.				Same
lanyard must ected to ring t cage.	None likely.	Work Cage			Same

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	REVISED	DATE

FIGURE 7.1
MSL BASE SUPPORT LEVELING

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FUNCTION: A MISSILE BASE SUPPORT LEVELING	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS
7) Read both level sensors.	Vision, touch, sound.	Determine that each sensor bubble is centered in the sensor scale.
8) (Assuming non-level missile base support.) Use socket wrench to loosen spring retaining plate lock bolts, four places for each leveling jack.	Vision, touch	Spring retaining plate to be loose.
9) Slide spring retaining plates toward launch tube wall until they contact wall. Use socket wrench to retighten spring retaining plate lock bolts.	Vision, touch, sound.	Decide when plate touch wall. Determine all bolts are tight.
10) Use a wrench to turn each leveling jack drive nut as required for level sensor bubble positions until bubbles are centered in both level sensors.	Vision, touch, Critical function or repetition necessary. Poor illumination could affect leveling.	Determine when both bubbles are centered.
11) Use an adjustable wrench to loosen spring retaining plate lock bolts (See attached fig. A-4) and slide spring retaining plates away from launch tube wall until plates are centered with respect to jacks.	Vision, touch. If bolts stick avoid excessive force.	Determination as to centering of plates in relatic to jack. Whether missile has been indexed to target azimuth.

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH A 10 FOOT DEEPER SILO - WING V

PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERRORS
Vision, touch, sound.	Determine that each sensor bubble is centered in the sensor scale.	2nd operator turns jack screws.	Oral communication between operator in cage and operator at missile base 20 ft down.	Safety lanyard must be connected to ring of work cage.	Sensor bubbles not centered.
Vision, touch	Spring retaining plate to be loose.	Loosen bolts with socket wrench.	No critical communication.	No critical requirement unless performed from work cage.	Bolts not sufficiently loosened.
Vision, touch, sound.	Decide when plates touch wall. Determine all bolts are tight.	Slide spring retaining plates - tighten plate bolts.	No critical communication.	No critical requirement unless performed from work cage.	Plates are not against wall and bolts are not properly retightened.
Vision, touch, Critical function or repetition necessary. Poor illumination could affect leveling.	Determine when both bubbles are centered.	Use wrench.	Oral response between operators.	Measure jack travel stem with steel rule and do not allow any jack stem to extend more than nine inches.	Jack stop could fail and cause equipment damage that may injure personnel.
Vision, touch. If bolts stick avoid excessive force.	Determination as to centering of plates in relation to jack. Whether missile has been indexed to target azimuth.	Torque required to loosen spring retaining plate lock bolts.	Voice communication between operators and SIN telephone communication to LCC and equipment room.	Adjustable wrenches are prone to slip. Care should be taken in applying force to avoid skinned knuckles of bruised hands or arms.	Poorly centered pl

2 DATA SHEET

SAFETY UIREMENTS	PROBABLE ERRORS	JOB AIDS OR TOOLS	NORMAL SILO	VS	DEEPER SILO WING V
lanyard must be ed to ring of ge.	Sensor bubbles not centered.	Adjustable wrench. 2nd operator			Distance between one operator and the other increased by 10 feet to approx. 20 feet.
ical requirement performed from ge.	Bolts not sufficiently loosened.	Socket wrench.			
ical requirement performed from ge.	Plates are not against wall and bolts are not properly retightened.	Socket wrench			
jack travel stem el rule and do w any jack stem d more than nine	Jack stop could fail and cause equipment damage that may injure personnel.	Wrench			
le wrenches are slip. Care e taken in force to avoid knuckles of hands or arms.	Poorly centered plates	Adjustable wrench			Same

FUNCTION: A MISSILE BASE SUPPORT LEVELING	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENT
12) Loosen thumbscrews and remove missile base support level set.	Vision, touch.	The decision th missile base su dead band level was or was not accomplished wa made.*
13) Place missile base support level set in storage case and secure storage case in work cage. Place tools in work cage and secure with tielines.	Vision, touch.	None critical.

*See Function B for Missile Base Support Dead Band Leveling Task Analysi

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH A 10 FOOT DEEPER SILO - WING V

PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERRORS
Vision, touch.	The decision that missile base support dead band leveling was or was not to be accomplished was made.*	Manual thumb-screw.	Oral communication to 2nd operator at silo base.	Safety lanyard attached to work cage ring.	None
Vision, touch.	None critical.	Manually secure	None critical.	All tools and equipment to be transported in work cage must be properly secured in work cage.	Damage to missile and equipment or injury to personn may result from a falling object.

SAFETY REQUIREMENTS	PROBABLE ERRORS	JOB AIDS OR TOOLS	NORMAL SILO	VS [redacted]
' lanyard attached k cage ring.	None	Work Cage.		Increased communication distance between operators
ols and equip- o be transported k cage must be ly secured in age.	Damage to missile and equipment or injury to personnel may result from a falling object.	Tiedown straps.		Same.

3

FUNCTION B: * DEAD BAND LEVELING MISSILE BASE SUPPORT	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS
1) Check level of missile base support as described in Function A.	As described in Function A.	As described in Function A.
2) Use adjustable wrench to turn No. 1 jackscrew clockwise until bubble motion is noted on one of the level sensors.**	Vision, touch.	Verify bubble motion.
3) Use adjustable wrench to turn jack No. 1 jackscrew clockwise until a change of two minutes of arc (approximately 2/3 of a gradient mark) from this initial bubble position is noted.	Vision, touch, ability to write legible numbers.	Interpretation minutes of arc relation to gr ient marks. C correlation in inter-operator derstanding of wrench turns v sus bubble rea
4) Use adjustable wrench to turn No. 1 jackscrew counter-clockwise and count the number of turns required to return the the level sensor bubble to the initial bubble position as noted in step (2). Record the number of turns. [1]		

[1] If the number of turns recorded in missile support suspension and alig

1

*NOTE: Verify that missile skirt umbilical cable connection procedures autonavigator umbilical have been performed before proceeding wi base support.

**NOTE: If bubble motion is noted in both level sensors, select the leve that indicates the greatest motion. Record bubble position.

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH A 10-FOOT DEEPER SILO - WING V

SUPPORT	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERRO
ap- A.	As described in Function A.	As described in Function A.	As described in Function A.	As described in Function A.	As described in Function A.	As described in Function A.
il	Vision, touch.	Verify bubble motion.	Visual and manual.	Oral communication between operators.	Safety lanyard operator in work cage.	Not detecting bubble motion.
	Vision, touch, ability to write legible numbers.	Interpretation of minutes of arc in relation to gradient marks. Close correlation in inter-operator understanding of wrench turns versus bubble readings.	70-ft. lb. of torque to wrench in a close environment interspersedwith oral communication and a decision making requirement.	Oral, between operators.	Safety lanyard in work cage.	Poor readings. Improper correlation between what operators understand and subsequent response.

If the number of turns recorded in B-3 exceeds 14 turns, suspend post emplacement operations. The missile support suspension and alignment system will require maintenance and possible missile removal.

umbilical cable connection procedures and procedures for connecting
ave been performed before proceeding with dead band leveling missile

in both level sensors, select the level sensor bubble
st motion. Record bubble position.

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SAFETY UIREMENTS	PROBABLE ERRORS	JOB AIDS OR TOOLS	NORMAL SILO	VS	DEEPER SILO WITH V
scribed in Func- A.	As described in Function A.	As described in Function A.			
y lanyard operator rk cage.	Not detecting bubble motion.	Wrench.			Illumination may be decreased. Oral communication more difficult depending on noise level from environmental supply duct now located above operators head at silo base.
y lanyard in eage.	Poor readings. Improper correlation between what operators understand and subsequent response.	Wrench, pencil, notebook. Skill in reading sensor bubble and communicating information to another operator for action.			

ions. The
ssile removal.

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FIGURE 7.2 ~~CONT.~~
DEAD BAND LEVELING

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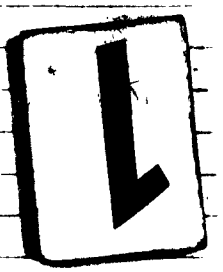
RS	JOB AIDS OR TOOLS	NORMAL SILO	VS	DEEPER SILO WING V
calcu-	Pencil, log book			Same
calcu-	Wrench			Same
driver screw	Applicable screw-driver			Same
not de-cadings, lation perators subse-	Wrench, level set, pencil, log book			If illumination is not adequate at deeper level operator fatigue may result sooner.
tered.	Wrench			Same



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FUNCTION: B DEAD BAND LEVELING MISSILE BASE SUPPORT	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS
5) Divide the number of recorded turns by 2 and subtract 1.	Vision	Information required from log book.
6) Turn jack No. 1 jackscrew clockwise the number of turns calculated in Function B-5.	Vision, touch	Information required from log book.
7) Tighten No. 1 leveling jack drive nut set screw.	Vision, touch	Decision as to proper screw se ting forces.
8) Repeat steps B-2 through B-7 for jack No. 2.	Vision, touch	Same as Functio B-3 and B-4 plu information required from log book.
9) Repeat steps B-2 through B-7 for jack No. 3.		
10) Use wrench to loosen spring retaining plate lock bolts and slide spring retaining plates away from launch tube wall until plates are centered with respect to leveling jacks.	Touch, vision. Critical that plates be centered.	Stress conditic brought on by f tigue from wren operation in s base could aff decision that plates were ce tered with resp to leveling ja

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH A 10-FOOT DEEPER SILO - WING V

ORT	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERRORS
	Vision	Information required from log book.	Mathematical calculation.	No critical communications if notes are not in doubt.	Wear protective head gear at all times when working in silo. (Wear and attach safety lanyard when in work cage).	Error in turn calculation.
	Vision, touch	Information required from log book.	Mathematical calculation			Error in turn calculation.
	Vision, touch	Decision as to proper screw setting forces.	Tighten set screw			Improper screw dri head can cause scr head damage.
	Vision, touch	Same as Function B-3 and B-4 plus information required from log book.	Environmental conditions and fatigue will effect operator potential. Time requirements will exceed preceeding operations due to operator fatigue.			Bubble motion not tected, poor readi improper correlati between what operc understand and sul quent response.
	Touch, vision. Critical that plates be centered.	Stress conditions brought on by fatigue from wrench operation in silo base could affect decision that plates were centered with respect to leveling jacks.	Same as Function B-8 & 9. (Time requirements needed but not available).			Plates not center

DATA SHEET

2

SAFETY REQUIREMENTS	PROBABLE ERRORS	JOB AIDS OR TOOLS	NORMAL SILO	VS	DEEPER SILO WING V
protective head at all times when in silo. (Wear each safety lan- yen in work cage).	Error in turn calculation.	Pencil, log book			Same
	Error in turn calculation.	Wrench			Same
	Improper screw driver head can cause screw head damage.	Applicable screw-driver			Same
	Bubble motion not detected, poor readings, improper correlation between what operators understand and subsequent response.	Wrench, level set, pencil, log book			If illumination is not adequate at deeper level operator fatigue may result sooner.
	Plates not centered.	Wrench			Same

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FIGURE 7.2 CON'T

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FUNCTION B: DEAD BAND LEVELING MISSILE BASE SUPPORT	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS
11) Use wrench to tighten spring retaining plate lock bolts.	Vision, touch. Do not over tighten.	Determine proper tightness.

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH A 10-FT DEEPER SILO - WING V

ORT	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERRORS
	Vision, touch. Do not over tighten.	Determine proper tightness.	Tighten bolts to proper torque.	No critical communications.	Wear protective head gear.	Loose bolts.

DATA SHEET

2

SAFETY REQUIREMENTS	PROBABLE ERRORS	JOB AIDS OR TOOLS	NORMAL SILO	VS	DEEPER SILO WING V
ptentive head	Loose bolts.	Wrench			Same

3

		REVISED	DATE	FIGURE 7.2 CONT.	
				THE BOEING COMPANY SEATTLE 24 WASHINGTON	D2-15132 P 26

FUNCTION: C SUMP PUMP REMOVAL, INSTALLATION AND MAINTENANCE	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENT
1) Three members assemble work cage.*		
2) Place vapor proof flood lamps in work area on second level and secure to provide light in lower launch tube area.**		
3) Enter elevator work cage and descend to missile base.*		
4) Remove sump cover plate by removing hold down nuts, attaching 5/8 inch eyebolt, positioning work cage over sump, attach rope to cage and eyebolt, and move work cage with cover to one side, lower to floor and detach rope.	Vision, touch; if bolts stick, avoid excessive force.	Where to move t sump cover plat where to attach rope to work ca
5) Remove water from sump by using hand pump to transfer water from sump to containers	Vision	Whether it is r quired to pump any excess of w where to transf the water.
6) Remove pumping unit by unbolting and removing cover support beam from sump, disconnect pump discharge piping, disconnect pump power cable at J-Box, and remove pump base hold down nuts	Vision, touch; if bolts stick, avoid excessive force.	To determine t sump pump is n functioning.

* See detailed task analysis for work cage, page 33

** See detailed task analysis for flood lamps, item 2, page 21

1

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH A 10-FOOT DEEPER SILO - WING V

PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERROR
Vision, touch; if bolts stick, avoid excessive force.	Where to move the sump cover plate, where to attach rope to work cage.	Torque required to loosen bolts and attach eye-bolt.	Voice communication between operators; and SIN telephone communication to LCC equipment room for emergency only.	Very easy to drop the sump cover if not properly tied to work cage-cover weight 125 lbs. Electrical power removed from pump.	Electrical pump c left on - cover s stick to sump and age may result t elevator work ca while pulling it
Vision	Whether it is required to pump out any excess of water where to transfer the water.	Pumping of hand pump.	Voice communication between operators; and SIN telphone communication to LCC equipment room for emergency only.	Slipping on wet silo floor. Electrical power removed from pump.	
Vision, touch; if bolts stick, avoid excessive force.	To determine that sump pump is malfunctioning.	Torque required to loosen bolts and nuts.	Voice communication between operators; and SIN telephone communication to LCC equipment room for emergency only.		

k cage, page 33

od lamps, item 2, page 21

DATA SHEET

2

SAFETY REQUIREMENTS	PROBABLE ERRORS	JOB AIDS OR TOOLS	NORMAL SILO	VS	DEEPER SILO WING V
sy to drop the ver if not pro- ied to work cage- eight 125 lbs. cal power re- rom pump.	Electrical pump cover left on - cover may stick to sump and dam- age may result to elevator work cage while pulling it loose.	541XD and/or 564XD wrench or crows foot rope. 5/8 inch eye bolt, work cage		Same	
g on wet silo Electrical power from pump.		541XD and 564XD hand pump. containers for water (30 gal. drum or like item).		Same	
		541XD or 564XD wrench or crowsfoot			

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FIGURE 7.3
SUMP PUMP HANDLING & MAINT

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FUNCTION: C SUMP PUMP REMOVAL, INSTALLATION AND MAINTENANCE	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS
7) Lift sump pump from sump by attaching a rope to the lifting lugs on the motor and to the elevator work cage; lift and lower to floor and detach rope; remove holddown nuts at motor base and detach motor from pump; place motor and pump on work cage platform and raise to equipment room level; hand carry motor and pump to access shaft and reassemble to facilitate handling; raise pumping unit to surface using truck hoist; lower replacement pump and motor to equipment room level; detach motor from pump and hand carry pump and motor to work cage; lower to sump floor and reassemble pumping unit; then attach rope to motor lift lugs and to work cage and lower pumping unit into sump using work cage as hoist.*	Vision, touch; if bolts stick avoid excessive force.	Where to move pump to prior lifting into w cage and vice versa.
8) The rest of the procedure for installation of the pump is just the reverse of steps 6, 5, and 4 (Function C).		

1

*See attached illustration of sump pump removal operation.

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH A 10-FT DEEPER SILO - WING V

PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERRORS
Vision, touch; if bolts stick avoid excessive force.	Where to move the pump to prior to lifting into work cage and vice versa.	Torque required to loosen bolts, lifting force to move motor and pump to and from the work cage and to hoist in access shaft.	Voice communication between operators; SIN telephone communication to LCC equipment room for emergency only.	Very easy to drop the pump if not properly tied to work cage. Pump weighs 117 lbs., motor above weighs 85 lbs.	Pump may stick to s and damage may resu to elevator work sa assembly in pulling base.

p removal operation.

DATA SHEET

2

SAFETY UIREMENTS	PROBABLE ERRORS	JOB AIDS OR TOOLS	NORMAL SILO	VS	DEEPER SILO WING V
asy to drop the f not properly o work cage. eighs 117 lbs., above weighs	Pump may stick to sump and damage may result to elevator work cage assembly in pulling it base.	541K0 and/or 564K0 wrench, mechanical maintenance truck, rope, work cage.			Same

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FIGURE 7.3 CONT

FUNCTION: C SUMP PUMP REMOVAL, INSTALLATION & MAINTENANCE	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS
9) Checkout the pump by returning the water from temporary storage to the sump; activate START-STOP switch if quantity of water is not sufficient to actuate float switch; observe that pump removes water from sump and place control switch in AUTO position.	Vision: to see that enough water is available and is check that water is removed from sump.	To determine water quanti is sufficien actuate floa switch.
10) If it is determined that the malfunction is in the check valve, then steps 4 through 9 (Function C) may be eliminated; turn HAND-OFF-AUTO switch for pump to OFF position and remove check valve using common hand tools.	Vision, touch: the check valve may be stuck by corrosion to its connecting pipes.	To determine fu ction is the check va
11) Install a new valve immediately using common hand tools, set HAND-OFF-AUTO to AUTO position.	Vision, touch: the check valve s hould hot be over torqued.	
12) If it is determined that the liquid level float switch is malfunctioning then steps 4 through 11 (Function C) may be eliminated; place circuit breaker for pump to OFF position, disconnect electrical wire to switch, remove hardware holding switch in place and remove switch.	Vision	To determine malfunction float switch

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH 10-FOOT DEEPER SILO - WING V

TENANCE	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS
mp by returning the rary storage to the START-STOP switch water is not suffi- e float switch; ob- removes water from control switch in	Vision: to see that enough water is available and is check that water is removed from sump.	To determine if water quantity is sufficient to actuate float switch.		Voice communication between operators; SIN telephone communication to LCC equipment room for emergency only.	Avoid spilling water on floor of silo.
mined that the mal- the check valve, hrough 9 (Function inated; turn HAND- for pump to OFF emove check valve and tools.	Vision, touch: the check valve may be stuck by corrosion to its connecting pipes.	To determine malfunction is in the check valve.	Torque required to loosen check valve from adjacent fittings.		
valve immediately and tools, set to AUTO position.	Vision, touch: the check valve s hould hot be over torqued.		Torque required to tighten valve in place.		
mined that the loat switch is mal- en steps 4 through) may be eliminated; breaker for pump to disconnect electri- itch, remove hard- witch in place and	Vision	To determine if malfunction is in float switch.			Insure circuit breaker is in OFF position.

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SAFETY UIREMENTS	PROBABLE ERROR	JOB AIDS OR TOOLS	NORMAL SILO	VS	DEEPER SILO WING V
pilling water r of silo.		31XO and/or 564XO			Same
	HAND-OFF-AUTO switch may not be turned to OFF position.				Same
					Same
circuit breaker FF position.	Circuit breaker left in AUTO position.				Same

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FIGURE 7.3 CONT

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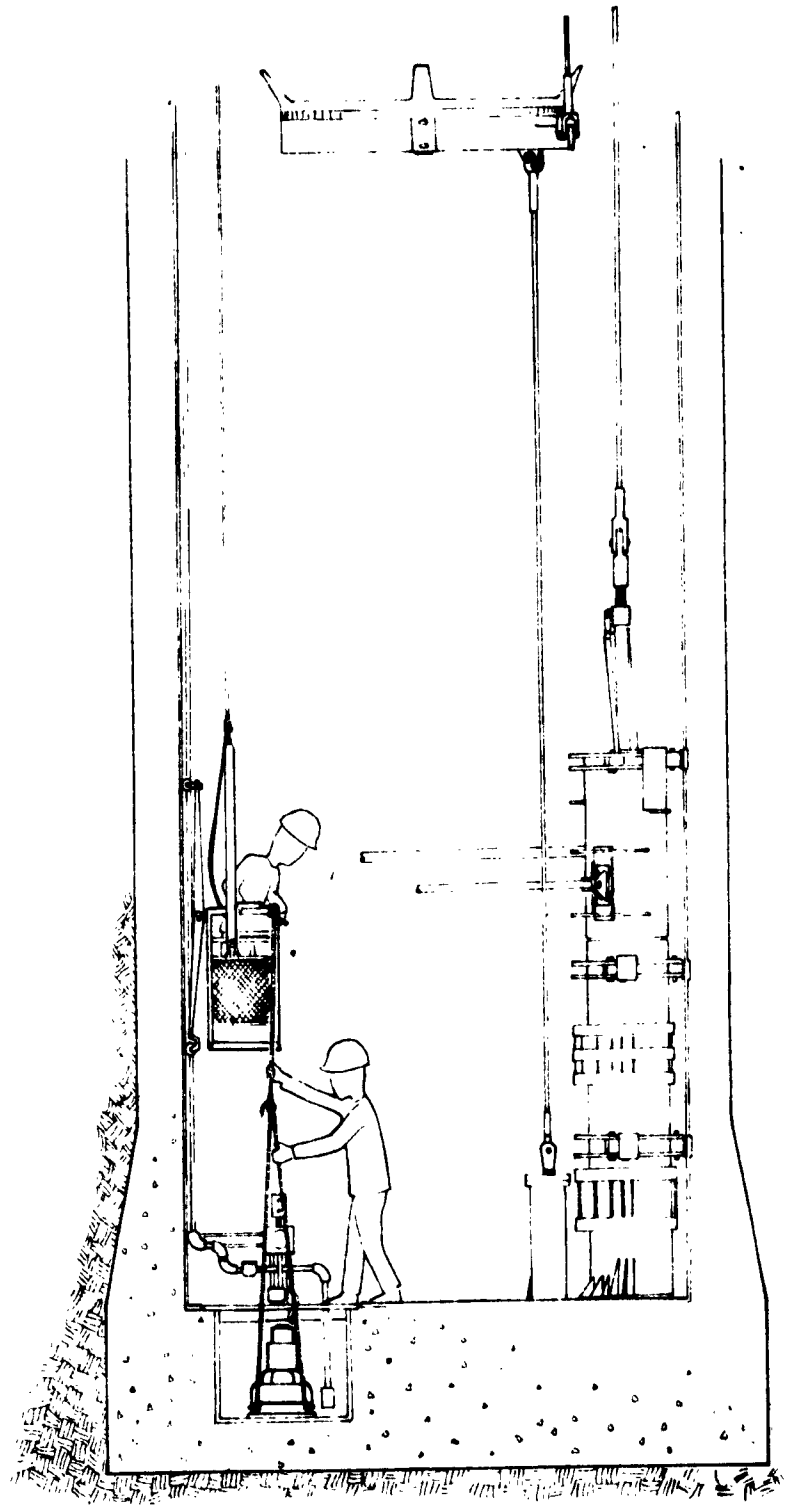

CALC			REVISED	DATE	FIGURE 7.3 CONT. SUMP PUMP REMOVAL OR INSTALLATION PUMP TUBE SYSTEM	GER
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FUNCTION: C SUMP PUMP REMOVAL, INSTALLATION & MAINTENANCE	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS
13) Position and attach a new float switch immediately after the removal of the defective switch; connect electrical wire to switch, return HAND-OFF-AUTO switch to AUTO position.	Vision	
14) Check out float switch by hand operation to determine if pump starts at high level and stops at low level.	Vision	
15) Prior to removal and replacement of various sump pump components fault isolation must taken place for a flooded sump condition by using START-STOP switch to determine that pump operates; check for electrical continuity across START-STOP switch; check for malfunction in motor starter; determine that water in sump is discharged when pump operates; see that check valves are open; check flexable hose on discharge line for leaks; check for electrical continuity across HAND-OFF-AUTO control switch; check for malfunction in high level relay switch.	Vision, inspection for leaks.	Determination of fault by isolation of components.

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH 10-FOOT DEEPER SILO - WING V

PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERRORS
Vision			Voice communication between operators; SIM telephone communication to LCC equipment room for emergency only.		
Vision					
Vision, inspection for leaks.	Determination of fault by isolation of components.			Avoid standing in damp areas of missile floor while making electrical tests.	Insuring that all valves are open, n seeing leaky condi

ENTS	PROBABLE ERRORS	JOB AIDS OR TOOLS	NORMAL SILO	VS	DEEPER SILO WING V
		541XO, electric lantern			Same
		541XO, electric lantern			Same
ding in damp missile floor ing electrical	Insuring that all check valves are open, not seeing leaky condition.	542XO or 541XO, liquid level indicator, multimeter, electric lantern.			Same

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FIGURE 7.3 CON'T

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FUNCTION: C SUMP PUMP REMOVAL INSTALLATION & MAINTENANCE	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS
16) Component fault isolation for a low water level condition in the sump should be accomplished by manually actuating the float switch, and testing the high level probe for a short circuit resulting in false high level indication	Vision	Determination of fault by isolation of components.
17) As a result of fault isolation the various items such as the sump pump discharge hose, high level alarm probe, START-STOP switch, motor starter relay, HAND-OFF-AUTO control switch, and the high level alarm relay must be removed, repaired and/or replaced (as well as the previously mentioned pump, check valve, and float switch).	Vision, touch	
18) Following repair check out must be accomplished on all items repaired (with the exception of the flexible hoses) by seeing that no high level alarm signal is generated unless water in sump is at high level; checking that START-STOP switch operates pump; checking that motor starts when HAND-OFF-AUTO switch operates properly; simulating high level in sump by applying jumper across terminals of high level probe to see that pump should start and high level alarm shoudl come on.	Vision	

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH 10-FOOT DEEPER SILO - WING V

PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERRORS
Vision	Determination of fault by isolation of components.		Voice communication between operators; SIN telephone communication to LCC equipment room for emergency only.	Avoid standing in damp areas of missile floor while making electrical tests.	
Vision, touch		Torquing required to remove and install various components	Voice communication between operators; SIN telephone communication to LCC equipment room for emergency only.		Electrical power must be off during replacement of electrical components.
Vision			Voice communication between operators; SIN telephone communication to LCC equipment room for emergency only.		

SAFETY UIREMENTS	PROBABLE ERRORS	JOB AIDS OR TOOLS	NORMAL SILO	VS	DEEPER SILO WING V
anding in damp missile floor king electrical		542XO or 541XO multimeter			Same
	Electrical power must be off during replacement of electrical components.				Same
					Same

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FIGURE 7.3 CONT.

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FUNCTION: D WORK CAGE UTILIZATION AT SILO BASE (LAUNCH TUBE BASE)	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS
This procedure requires three (3) personnel - one in equipment room, two in work cage.		
1) Identical to those of step (1) of Function "A".		
2) Identical to those of step (2) of Function "A".		
3) Place tool kit in work cage. Elevator work cage * will be lowered and positioned adjacent to, e.g., azimuth drive motor and first stage gear reduction.** Utilize work cage control pendant (P/N 25-18099-1 or P/N 25-18099-2): a) Depress DOWN-RIGHT switch. Set cage on silo floor. b) Depress TRAVERSE and DOWN-RIGHT switches.	Visual, tactual	Estimates requi for vertical an traverse distan
4)*** Wings I through V require two personnel in work cage. Man #1 leaves work cage for floor of silo. Man #2 remains in work cage.	Visual, tactual	Equipment room personnel: esti mate required o adequacy of sli application; ac curacy of sling to hoist attach ment; speed of lowering.

1

* Procedures for entering work cage, precautions to be observed, detailed in
** It is anticipated that no maintenance will be required on this unit up to
If maintenance should be required beyond the motor and first stage reducti
including base support ring will require removal. (This would necessitate
The weight of this combined unit (Azimuth drive motor, first and downstage
base support ring) is 7000 pounds, and would require a crane

TASK ANALYSES OF OPERATIONS ASSOICATED WITH 10-FOOT DEEPER SILO - WING V

PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERRORS
- Visual, tactual ge ge r t R	Estimates required for vertical and traverse distances.	Digital pressure: minimal	Communication may be required with personnel in equipment room (voice), or via telephone with maintenance support vehicle, SM80A, SM80B.		Over/under astimat of vertical/traver distance; press wr button. Failure t utilize safety lan yard. Failure to take tool kit.
- Visual, tactual es #2	Equipment room personnel: estimate required of adequacy of sling application; accuracy of sling to hoist attachment; speed of lowering.	Attachment of sling to ladder; attachment of package to hoist; operation of hoist.	With equipment room (voice)	Accuracy in attachment of package to sling and hoist. Safety belt for use on ladder.	Slipping or fallin off ladder through error in attachmen of sling or hoist. Failure to utilize safety belt.

recautions to be observed, detailed in T.O. SM80A-2-10
will be required on this unit up to a period of three years.
yond the motor and first stage reduction gear, the complete unit,
uire removal. (This would necessitate removal of the missile)
imuth drive motor, first and downstage gear reduction,
000 pounds, and would require a crane for removal.

***Step 4 and 5A apply to Wings I through V, regular silo; step 5B applies to Wing V deeper silo only.

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JFETY IREMENTS	PROBABLE ERRORS	JOB AIDS OR TOOLS	NORMAL SILO	VS	DEEPER SILO WING V
	Over/under astimate af vertical/traverse distance; press wrong button. Failure to utilize safety lanyard. Failure to take tool kit.	Standard tool kit for work cage. Torque wrench may be required: information not available.	Ability to estimate spatial relationships.		Provide 10 feet more cable on drum according to BCP 539R1. Power and communications cables must have same requirement for additional length.
oay in attach- of package to ; and hoist. y belt for use ddar.	Slipping or falling off ladder through error in attachment of sling or hoist. Failure to utilize safety belt.	Hoist, sling, tagling, safety belt.	Consientious observance of task requirements.		

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FIGURE 7.4
WORK CAGE AT SILO BASE

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FUNCTION: D WORK CAGE UTILIZATION AT SILO BASE (LAUNCH TUBE BASE)	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS
5A) Where azimuth drive motor requires removal, procedure would require two men as follows: Man #1 - position 12-foot ladder under motor. Wear safety belt on mounting ladder. Man #2 - depress UP-LEFT switch and ascend approximately 30 feet. Depress TRAVERSE and DOWN-RIGHT buttons for vertical alignment of work cage with motor. Man #3 - use sling to fasten hoist lugs on motor to hoist ring on elevator work cage.	Visual, tactual	Placement of la der for maximum efficiency duri operation. De- termine alignme Determine adequ of sling fasten
5B) a. Equipment room personnel will disconnect all power to work cage at instigation of personnel at silo base.	Visual, tactual	Silo base perso will determine cage is resting silo floor.
b. Personnel at base of silo will communicate with equipment room personnel to assure power has been disconnected.	Auditory	
c. Personnel (silo base) will attach a tagline to hoist on work cage.	Tactual	Determine adequ of tagline attac ment and point attachment.
d. Personnel (silo base) will then disconnect hoist cable and power and communication cable	tactual, kinesthetic	Minimal

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH 10-FOOT DEEPER SILO - WING V

	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERRO
ps ltion r und e- ttons age to list	Visual, tactual	Placement of ladder for maximum efficiency during operation. Determine alignment. Determine adequacy of sling fastening.	Placement of ladder; attachment of hoist. Depress controls.	Voice communication between two personnel at base of silo. Possible requirement for voice communication with personnel in equipment room.	Adequate caution in use of ladder and care in attachment of hoist and sling.	Careless use of l inadequate cautio attachment of al and safety belt. to wear safety be work cage or on l
	Visual, tactual	Silo base personnel will determine work cage is resting on silo floor.	Pull circuit breakers.	Receive message (voice) that work cage is resting on silo floor.	None	No circuit breake pulled; wrong cir breakers pulled.
l	Auditory		Communicate with personnel in equipment room; receive confirmation of power disconnect.	Send and receive (See Action column).	None	Garbled communica tions.
	Tactual	Determine adequacy of tagline attachment and point of attachment.	Attach tagline to hoist cable.	None	None	Inadequate attach ment: cable lengt would be insuff for manipulation.
	tactual, kinesthetic	Minimal	Hoist: remove hook. Power & communications; wrist rotation, abduction.	None	Must have received incontrovertible evidence of power disconnect.	Bend or break con nector pins on di connect.

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TASK ANALYSES OF OPERATIONS ASSOCIATED WITH 10-FOOT DEEPER SILO - WING V

N AT SILO BASE BASE)	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS
ive motor requires re would require ws: Man #1 - position nder motor. Wear ounting ladder. UP-LEFT switch and tely 30 feet. De- nd DOWN-RIGHT buttons gnment of work cage #3 - use sling to s on motor to hoist work cage.	Visual, tactual	Placement of ladder for maximum efficiency during operation. Determine alignment. Determine adequacy of sling fastening.	Placement of ladder; attachment of hoist. Depress controls.	Voice communication between two personnel at base of silo. Possible requirement for voice communication with personnel in equipment room.	Adequate caution in use of ladder and care in attachment of hoist and sling.
m personnel will l power to work gation of per- o base.	Visual, tactual	Silo base personnel will determine work cage is resting on silo floor.	Pull circuit breakers.	Receive message (voice) that work cage is resting on silo floor.	None
base of silo will ith equipment l to assure power onnected.	Auditory		Communicate with personnel in equipment room; receive confirmation of power disconnect.	Send and receive (See Action column).	None
lo base) will ine to hoist on	Tactual	Determine adequacy of tagline attachment and point of attachment.	Attach tagline to hoist cable.	None	None
lo base) will ct hoist cable communication	tactual, kinesthetic	Minimal	Hoist: remove hook. Power & communications: wrist rotation, abduction.	None	Must have received incontrovertible evidence of power disconnect.

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AFETY IREMENTS	PROBABLE ERRORS	JOB AIDS OR TOOLS	NORMAL SILO	VS	DEEPER SILO [illegible]
te caution in ladder and care achment of hoist ing.	Careless use of ladder; inadequate caution in attachment of sling, hoist and safety belt. Failure to wear safety belt in work cage or on ladder.	Hoist, sling, safety belt,			
	No circuit breakers pulled; wrong circuit breakers pulled.	None			
	Garbled communications.	None			
	Inadequate attachment: cable length would be insufficient for manipulation.	Tagline			
ave received rovertible evi- of power dis- t.	Bend or break connector pins on disconnect.	Torque wrench			

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FIGURE 7.4 CONT.

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FUNCTION D WORK CAGE UTILIZATION AT SILO BASE (LAUNCH TUBE BASE)	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS
5B) Continued		
e. Personnel will remove tool kit and items of excessive weight from work cage, and manually maneuver cage into position immediately below azimuth drive motor. Replace tool kit, etc.	Visual, tactual, kinesthetic	Approximate ali ment of cage wi motor.
f. Equipment room personnel will attach line to traversing motor, and utilize this line to pull work cage traverse motor until it is in vertical alignment with work cage, immediately above azimuth drive motor.	Visual, tactual	Approximate ali ment of travers motor with work cage.
g. Personnel at silo base will reconnect hoist and power and communications cables.	Visual, tactual	Evaluation of connect operati
h. Inform equipment room personnel of connection. Equipment room personnel reconnect power.	Equipment room personnel: auditory, tactual	
i. Enter work cage and attach safety belt, depress UP-LEFT switch and hold until maximum ascent is achieved. Fasten sling to hoist lugs on motor and to hoist ring on work cage.	Visual, tactual	Maximal height

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH 10-FOOT DEEPER SILO - WING V

PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERRORS
Visual, tactual, kinesthetic	Approximate alignment of cage with motor.	Remove excess items from work cage. Move cage manually.			Drop items being moved from cage, alignment of cage motor.
Visual, tactual	Approximate alignment of traverse motor with work cage.	Attach line; pull motor to desired position.	Possible check with personnal below.		Line not adequatel attached; misalig
Visual, tactual	Evaluation of connect operation.	Hoist: insert hook; power and communication: push connector parts together; rotate knurled nut to complete connection.			Bend or break connector pins; fail connect hook.
Equipment room personnel: auditory, tactual		Connect power.	Receive		Garbled communication; failure to connect power.
Visual, tactual	Maximal heighth.	Depress button.		Requirement for wearing safety belt.	Press wrong button Failure to wear sa ty belts.

AFETY IREMENTS	PROBABLE ERRORS	JOB AIDS OR TOOLS	NORMAL SILO	VS	DEEPER SILO WING V
	Drop items being removed from cage. Misalignment of cage with motor.		Not applicable		Spatial relationships (alignment)
	Line not adequately attached; misalignment.	Tagline	Not applicable		Spatial relationships (alignment)
	Bend or break connector pins; fail to connect hook.	Torque wrench	Not applicable		Care in connection of electrical connector.
	Garbled communication; failure to connect power.		Not applicable		None
nt for wearing lt.	Press wrong button. Failure to wear safety belts.	Safety belt (standard for work cage.	Not applicable		Spatial relationships

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FIGURE 7.4 CON'T.

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FUNCTION: D WORK CAGE UTILIZATION AT SILO BASE (LAUNCH TUBE BASE)	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS
6) Loosen and remove bolts fastening azimuth drive motor and first stage gear reduction to base support ring. Ease motor into suspended position. Stow all nuts, bolts, etc., in pouch.	Visual, tactual, kinesthetic.	Point of operat at which motor quires support.
7A)* Ladder is hoisted. Procedure is reverse of step number 4 (Function D). Two men ascend in work cage.		
7B) Personnel in work cage will depress DOWN-RIGHT switch and bring work cage to rest on silo floor. Steps detailed under 5B (Function D) will be performed in reverse order.		
8) Lowering of azimuth drive motor will be the reverse of raising.		
9) Replacing of azimuth drive motor will be reverse of removal.		
10) Check azimuth drive motor by performing steps 1 through 3, inclusive, of para. 5, page 11, D2-14702.	Visual, tactual	Evaluate mecha ical response a follow sequenc Time estimate (minimal)

* Step 7A applies to Wings I through V, regular silo; step 7B applies to Wing V deeper silo.

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH 10-FT DEEPER SILO - WING V

PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERRORS
Visual, tactual, e kinesthetic. g. .	Point of operation at which motor requires suppert.	Remove bolts, etc. Ease motor to full suspension. Stow loose bolts, etc.		Care on ladder while guiding motor. Safety belt.	Lack of care in di mounting motor. F ure to wear safety
Visual, tactual 02.	Evaluate mechanical response and follow sequence. Time estimate (minimal)	Follow steps in procedure: activate controls. Engage adapter ring. Lock downs. Connect cables. Close circuit breaker			Activate wrong con Inadequate adapter lock down, incompl connection of cabl Failure to close c breaker.

regular silo;

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SAFETY REQUIREMENTS	PROBABLE ERRORS	JOB AIDS OR TOOLS	NORMAL SILO	VS	DEEPER SILO WING V
ladder while motor. Safety	Lack of care in dismounting motor. Failure to wear safety belt.	Hoist, sling, tagline, ladder, wrench, safety belt.			
	Activate wrong control. Inadequate adapter ring lock down, incomplete connection of cables. Failure to close circuit breaker.	Possible torque wrench; information not available.			

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FIGURE 7.4 CONT

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FUNCTION: E INSTALLATION & MAINTENANCE OF SIM INTER-COMMUNICATIONS JACK BOX	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS
1) Operator utilizes work cage to install extension cable to SIM inter-communication Jack Box.	Vision and touch	Must maintain hc alignment to sui clamp holes.
2) Install SIM inter-communication J-Box to silo wall using four phillips head screws.	Vision and touch	
3) Remove cover and wire box (4 slotted head screws required).	Vision and touch	Which wires go where. Highly critical operation. If not correct, commun cation will not exist.

1

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH A 10-FT DEEPER SILO - WING V

PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERROR
Vision and touch	Must maintain hole alignment to suit clamp holes.	Two holes must be drilled into concrete at approx. 14 inch intervals.	If SIN communication is considered necessary at the operational site	Safety lanyard must be connected to ring	Difficult to align holes when working from a moving platform.
Vision and touch					
Vision and touch	Which wires go where. Highly critical operation. If not correct, communication will not exist.	Maintenance is reversed of steps 2 and 3 (Function E)	Oral communication between operatom.	Electrical power should be disconnected.	Color coding on wire.

SAFETY REQUIREMENTS	PROBABLE ERRORS	JOB AIDS OR TOOLS	NORMAL SILO	VS	DEEPER SILO WING V
ty lanyard must connected to ring	Difficult to align holes when working from a moving platform.	Star drill, hammer, screw driver.			
trical power ld be disconed.	Color coding on wire.	Wire strippers, screw driver.			

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FIGURE 7.5
SIN J - BOX

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FUNCTION: F INSTALLATION AND MAINTENANCE OF MOTION SENSING TRANSDUCERS	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS
1) Operator utilizes work cage to install lowest level Motion Sensing Transducer, using 4 phillips head screws	Vision, touch	Must maintain hole alignment suit clamp hole
2) Remove cover and wire box.	Vision, touch	Which wires go where?

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH A 10-FT DEEPER SILO - WING V

PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK / FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERRORS
Vision, touch	Must maintain hole alignment to suit clamp holes.	Four holes must be drilled into concrete.	Oral communication between operators.	Safety lanyard must be connected to work cage yoke ring.	Difficult to maint holes alignment whe working from a mov platform.
Vision, touch	Which wires go where?	For maintenance remove faulty transducer and replace.	Oral communication		Color coding on wi

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AFETY IREMENTS	PROBABLE ERRORS	JOB AIDS OR TOOLS	NORMAL SILO	VS	DEEPER SILO WING V
Lanyard must be to ad. work cage ng.	Difficult to maintain holes alignment when working from a moving platform.	Star drill, hammer and screw driver.			Transducer is 14 feet from silo floor rather than 6 feet.
	Color coding on wire.	Wire strippers, open end wrench.			

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FIGURE 7.6
SECURITY TRANSDUCER

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FUNCTION: G PREPARATION & REMOVAL OF MISSILE	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS
1) Descend in properly prepared work cage to a point opposite missile tie-point junction box on silo wall. Attach earth ground cable to grounding strap on outside of missile support ring adapter and to connector lugs in tie-point junction box.	Vision, touch	Has a proper ground contac been establis Do I know pro attach points
2) Attach missile skirt grounding strap to grounding clip on inside of missile support ring.	Vision, touch	Has a proper ground contac been establis Do I know pro attach points
3) Install hoist support hook on receive ring and missile base support ring.	Vision, touch	Is hoist supp hook flush wi receiver ring missile base port ring.
4) Hand torque adjustment nut to maximum possible torque to insure adequate preloading.	Vision, touch. A great variance may exist between hand torque ability of various air men. An adjustment nut torque study should be made to ascertain requied torque and 5% to 95% percentile man adequacy.	Is this force sufficient to meet requires of the T.O.?

* Function G is to be reversed for Missile Preparation for Emplacement

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH 10-FOOT DEEPER SILO - WING V

PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERRORS
Vision, touch	Has a proper earth ground contact been established? Do I know proper attach points?	Manual connection of earth ground cable.	Telephone with microphone headset.	Protective head gear worn. Safety lanyard attached to work cage ring. Safety shoes.	Poor ground attach made.
Vision, touch	Has a proper earth ground contact been established? Do I know proper attach points?	Manual connection of earth ground cable.	Telephone with microphone headset.		Poor ground attach made.
Vision, touch	Is hoist support hook flush with receiver ring and missile base support ring.	Manual manipulation of hoist support hook.	Telephone with microphone headset.		If hoist support h is properly seated error possible.
Vision, touch. A great variance may exist between hand torque ability of various air men. An adjustment nut torque study should be made to ascertain requied torque and 5th to 95th percentile man adequacy.	Is this force sufficient to meet requirements of the T.O.?	Hand torque adjustment nut..	Telephone with microphone headset.		Loose adjustment n

Missile Preparation for Emplacement

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SAFETY QUIREMENTS	PROBABLE ERRORS	JOB AIDS OR TOOLS	NORMAL SILO	VS	DEEPER SILO WING V
ive head gear Safety lanyard d to work cage Safety shoes.	Poor ground attachment made.	Basic knowledge of electrical circuitry. Technical Manual, tool kit, sling rod cover set.		Same	
	Poor ground attachment made.	Basic knowledge of electrical circuitry. Technical Manual, tool kit, sling rod cover set.		Same	
	If hoist support hook is properly seated no error possible.	Normal mechanical skills. AF number not available.		Same	
	Loose adjustment nut.	Sufficient hand torque force to tighten to maximum expected.		Same	

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FIGURE 7.7
MISSILE REMOVAL

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FUNCTION: 6 PREPARATION & REMOVAL OF MISSILE	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS
5) Attach hoist chain to hoist support hook.	Vision, touch	Is it attached?
CAUTION: Use extreme care when handling missile skirt umbilical cable head in steps 6 through 14. Cable head contains shear pins which may be sheared if cable head is bumped, pulled or otherwise mishandled.		
6) Position lower cable grip around missile skirt umbilical cable with cable grip lanyards up.	Vision touch, good illumination.	Insure cable positioned correctly.
7) With rawhide lace, lace from top down in a criss cross pattern through approximately every third loop and secure rawhide lace with a square knot. Distance between umbilical head lanyards and cable grip lanyard shoudl be approximately four feet.	Vision, touch	Insure that distance is approximately four fe
8) Extend chain hoist and attach hook to lanyards.	Vision, touch	

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TASK ANALYSES OF OPERATIONS ASSOCIATED WITH 10-FOOT DEEPER SILO - WING V

	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERRORS
rt	Vision, touch	Is it attached?	Manual connection	Telphone with micro- phone headset.	Protective head gear worn. Safety lanyard attached to work suppo ring. Safety shoes.	No probable error
ng	missile through 14. may be sheared herwise mis-					
h	Vision touch, good illumina- tion.	Insure cable po- sitioned correct- ly.	Manual manipu- lation.			See Caution Note p ceding Step 6.
	Vision, touch	Insure that dis- tance is approxi- mately four feet.	Manual manipu- lation.			See Caution Note p ceding Step 6.
ce-						
ok	Vision, touch		Manual manipu- lation.			See Caution Note p ceding Step 6.

AFETY INCIDENTS	PROBABLE ERRORS	JOB AIDS OR TOOLS	NORMAL SILO	VS	DEEPER SILO WING T	
ve hand gear afety lanyard he work cage afety shoes.	No probable error	Manual-visual coordination.		Same		5
	See Caution Note preceding Step 6.	Basic knowledge of electrical circuitry, Technical Manual, tool kit, sling rod cover set.		Same		6
	See Caution Note preceding Step 6.	Manual-visual coordination.		Same		7
	See Caution Note preceding Step 6.	Manual-visual coordination.		Same		

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FUNCTION: 0 PREPARATION & REMOVAL OF MISSILE	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS
9) Operate chain hoist until weight of umbilical is on hoist.	Vision, touch good illumination	Insure that umbilical weight is on hoist.
* 10) Loosen two bolts attaching umbilical clamp halves to clamp bracket and loosen clamp bracket bolts.	Vision, touch good illumination	Bolts are loose
11) Loosen bolt and swing clamp clear of missile skirt umbilical.	Vision, touch good illumination	Clamp is clear of umbilical
12) Remove bolts and remove umbilical head lanyards from bolts; reinstall bolts.	Vision, touch good illumination	Recheck to be sure bolts are reinstalled.
13) Remove umbilical head threaded receptacle from raceway cable connector with strap wrench.	Vision, touch good illumination	Are threads stripped?
14) Lower umbilical cable with chain hoist until protective cap can be installed. Install cap.	Vision, touch good illumination	
15) Lower umbilical cable until clear of missile base support and disconnect cable grip lanyards from chain hoist hook.	Vision, touch good illumination	
NOTE: Lower cable grip assembly shall remain secured to skirt umbilical cable until skirt umbilical is reinstalled.		

* When missile skirt umbilical cable requires maintenance, steps 10 through 13 should be included in umbilical cable Remove/Replace procedu

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TASK ANALYSES OF OPERATIONS ASSOCIATED WITH 10-FOOT DEEPER SILO - WING V

PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERRORS
f Vision, touch good illumination	Insure that umbilical weight is on hoist.		Telephone with microphone headset.	Protective head gear worn. Safety lanyard attached to work cage ring. Safety shoes.	See Caution Note preceding Step 6
Vision, touch good illumination	Bolts are loosened	Manual and mechanical manipulation			
Vision, touch good illumination	Clamp is clear of umbilical	Manual and mechanical manipulation			
Vision, touch good illumination	Recheck to be sure bolts are reinstalled.	Manual manipulation			
Vision, touch good illumination	Are threads stripped?	Manual manipulation			
Vision, touch good illumination		Manual manipulation			Cap is loose
Vision, touch good illumination		Manual manipulation			

hall remain secured to
umbilical is reinstalled.

requires maintenance, steps 10
bilical cable Remove/Replace procedures.

FETY REMENTS	PROBABLE ERRORS	JOB AIDS OR TOOLS	NORMAL SILO	VS	DEEPER SILO WING V
ve head gear afety lanyard to work cage afety shoes.	See Caution Note preceding Step 6	Manual-visual coordination			Same
					Same
					Same
	Cap is loose				

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FIGURE 7.7 CONT'

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FUNCTION: G PREPARATION & REMOVAL OF MISSILE	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS
16) Remove chain hoist from hoist support hook and remove hook from receiver ring and missile base support.	Vision, touch, good illumination	
17) Swing umbilical clamp-half into place and tighten clamp-half bolt. Tighten clamp bracket bolts.		
18) Operate power azimuth drive controller, visually positioning missile raceway halfway between support arms 1 and 2.		Try to get s close to cen as possible.
19) Align center or receiver ring ear that is nearest arm 1 with centerline of arm 1 within ± one-half inch.		Is tolerance within ± ½ i
20) Return to base of missile and verify step 19. If ear is not centered, rotate missile as necessary.		Is tolerance within ± ½ i
21) Position adapter ring to missile skirt clamps set. Bolts attaching missile skirt to missile support ring adapter should be hand tightened.		Attachment been made a bolts only tight.

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH 10-FOOT DEEPER SILO - WING V

	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERROS
up- re- upport.	Vision, touch, good illumination		Manual manipulation	Telephone with microphone headset.	Safety shoes, hat and lanyards.	
olt.			Manual manipulation.			
a- n		Try to get as close to center as possible.	Manual manipulation and visual judgment			Error in visual ment would requi more time on ste 19 and 20.
ear ter- f		Is tolerance within ± ½ in.	Fine manual manipulation			Won't be within ance necessary i Step 20.
		Is tolerance within ± ½ in.	Manual-visual manipulation			Judgment error
le hing art ght-		Attachment has been made and bolts only hand tight.	Manual manipulation			

AFETY REMENTS	PROBABLE ERROS	JOB AIDS OR TOOLS	NORMAL SILO	VS	DEEPER SILO WING V
r shoes, hat unyards.		High manual-visual coordination, plus Step 1 of this Function			
	Error in visual judgment would require more time on steps 19 and 20.				
	Won't be within tolerance necessary in Step 20.				
	Judgment error				

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FIGURE 7.7 CON'T.

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FUNCTION: C PREPARATION & REMOVAL OF MISSILE	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS
22) Torque 16 clamp set bolts to 1200 (± 50) inch pounds	Vision, touch, good lighting	Torquing is co rect and torqu wrench is with calibration da
23) Adjust each positioning post to fixed position by removing adjustment nut lockpin and turning adjustment until positioning pin can be installed in positioning post. Install positioning pin.	Vision, touch, good lighting	Alignment is correct
24) Install adjustment nut lockpin and remove positioning pin from positioning post.	Vision, touch, good lighting	Alignment is correct
25) Feed quick release pin and positioning pin on positioning post down through mounting bracket on missile support ring adapter.	Vision, touch, good lighting	Alignment is correct
26) Continue feeding positioning post until quick release pin hole in positioning post aligns with hole on side of mounting bracket. Install quick release pin.	Vision, touch, good lighting	Alignment is correct

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH A 10-FOOT SEEPER SILO - WING V

	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK	ACTION FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERRO
00	Vision, touch, good lighting	Torquing is correct and torque wrench is within calibration date.	Manual	Manipulation	Telephone with microphone headset.	Safety hat	Torque error
st- just- be In-	Vision, touch, good lighting	Alignment is correct	Manual	manipulation	Telephone with microphone headset.	Safety hat	
and ition-	Vision, touch, good lighting	Alignment is correct	Manual	manipulation	Telephone with microphone headset	Safety hat	
- n	Vision, touch, good lighting	Alignment is correct	Manual	manipulation	Telephone with microphone headset.	Safety hat	
st le n-	Vision, touch, good lighting	Alignment is correct	Manual	manipulation	Telephone with microphone headset.	Safety hat	

SAFETY EQUIREMENTS	PROBABLE ERRORS	JOB AIDS OR TOOLS	NORMAL SILO	VS	DEEPER SILO WING V
hat	Torque error	Mechanical visual-manual			Same
hat					Same
hat					Same
hat					Same
hat					Same

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FIGURE 7.7 CONT

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FUNCTION: G PREPARATION & REMOVAL OF MISSILE	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS
27) After pre-removal operation at top of silo have been completed, an observer will be slotted in launcher-equipment room. Headset communications will be established between this observer and operator of hoist rods (at ground level) in order to inform operator of clearances at silo base.	Proper lighting, vision, touch, audio.	Judgment of clearance
28) Attach hoist sling rods to mating missile support ring adapter fittings as follows:	Proper lighting, vision, touch, audio	Are sling rod ends in good co dition before attachment?
a) Take missile grounding cable from T-E support truck and lower all but 5 feet into the launch tube.		
b) After lowering work cage to missile base, attach end of grounding cable to missile support ring adapter.		Is proper earth ground establis at both upper a area and missil support ring.
c) Stow permanent cable in work cage.		
d) Remove sling rod ends covers and stow in work cage.		To tie articles down in work ca
e) Insure that hoist sling rods have been lowered sufficiently for proper alignment of bolt holes in mating fittings of sling rods and support ring adapter. If sling rods will not mate it will be necessary to open control panel and depress LOWER button until sling rod fittings can be connected to the support ring adapter fitting.		Are bolt holes clear of dirt a not damaged? Is alignment corre for connection?

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH A 10-FOOT DEEPER SILO - WING V

PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERROR
Proper lighting, vision, touch, audio.	Judgment of clearance	Establish communications	Telephone with microphone headset.	Protective head gear Safety lanyards while in work cage. Are hoist cables taut and free from all encumbrances? Have any objects fallen from T-E which must be retrieved?	Fouled hoisting gear Damaged hoist rod en Frayed hoist cables not noticed?
Proper lighting, vision, touch, audio	Are sling rod ends in good condition before attachment?	Attach rod ends.	Telephone with microphone headset.		
	Is proper earth ground established at both upper silo area and missile support ring.	Make earth ground attachment.			Not attached correctly.
	To tie articles down in work cage. Are bolt holes clear of dirt and not damaged? Is alignment correct for connection?				Trouble with connection.

DATA SHEET

ETY EMENTS	PROBABLE ERROR	JOB AIDS OR TOOLS	NORMAL SILO	VS	DEEPER SILO WING V
re head gear anyards while in e. Are hoist ut and free encumbrances? objects fallen which must be d?	Fouled hoisting gear. Damaged hoist rod ends. Frayed hoist cables not noticed?	Tool kit, technical manual, sling rod end covers for emplacement.	Same		
	Not attached correctly.				
	Trouble with connection.				

3

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FIGURE 7.7 CONT.

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FUNCTION: G PREPARATION & REMOVAL OF MISSILE	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS
28) Continued		
f. Remove sling rod mounting bolts and position sling rod fittings in respective fittings on missile support ring adapter.	Vision, touch	
g. Install mounting bolts attaching sling rods to ring adapter.		
h. Tighten mounting bolts and install cotter pins.		Are bolts tight
i. Disengage adapter ring lock downs by pulling handle out as far as possible and rotating 45 degrees from vertical in either direction. Handle must always be above gear teeth on receiver ring.		Is handle out as far as possibl Is handle above gear teeth?

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH A 10-FOOT DEEPER SILO - WING V

'AL OF MI.SILE	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK OF FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS
g rod mounting bolts n sling rod fittings ve fittings on mis- t ring adapter. nting bolts attach- ods to ring adapter.	Vision, touch		Manual-mechani-cal manipulation	Telephone with micro-phone headset.	Safety hat and shoes
nting bolts and in- r pins.		Are bolts tight			
dapter ring lock lling handle out as ible and rotating from vertical in ction. Handle must bove gear teeth on ng.		Is handle out as far as possible? Is handle above gear teeth?			

DATA SHEET

1

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH A 10-FOOT DEEPER SILO - WING V

PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK OF FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERROR
Vision, touch		Manual-mechanical manipulation	Telephone with microphone headset.	Safety hat and shoes	
	Are bolts tight				
	Is handle out as far as possible? Is handle above gear teeth?				

DATA SHEET

2

FETY REMENTS	PROBABLE ERROR	JOB AIDS OR TOOLS	NORMAL SILO VS DEEPER SILO WING V
at and shoes		Mechanical visual-manual	Same

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FIGURE 7.7 CONT.

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8.0 ACO EFFECTS

8.1 ACO 216 FIXTURE, MISSILE SUSPENSION SYSTEM LOADING

8.1.1 Figure 8.1 depicts the new configuration required to make ACO 216 compatible with the deeper launch tube. The required revision consists of adding an additional rod and turnbuckle section to the existing linkage. Specific changes are:

(a) Two new linkage rods (each approximately 5 feet in length)

(b) Two additional MK 25-26228-213 turnbuckles

(c) New pallet or box to hold rods and turnbuckles

(d) Reworked shipping fixture to hold pallet or box. Fixture will employ brackets to assist the assembly of sections prior to installing tool in launcher.

8.1.2 Change will be accomplished under ECP 559. Wing V A & CO requirements document will include this change in the basic release. A new ACO number (ACO 216.5) is recommended.

8.2 ACO 215 FIXTURE - HOLE LOCATING, MISSILE SUSPENSION SYSTEM SPRING CAN

8.2.1 Figure 8.2 depicts the new configuration required for ACO 215 targets. An additional circle has been added to the target to measure tolerance.

8.2.2 The change is necessary because the deeper launcher caused an increase in the missile suspension pulley bracket out-of-tolerance requirement. This requirement is measured by dropping plumbobs from the pulley brackets to the targets on ACO 215.

8.2.3 Change will be accomplished under ECP 559. A new ACO number (ACO 215.5) is recommended.

8.3 NO OTHER ACO ITEMS ARE AFFECTED.

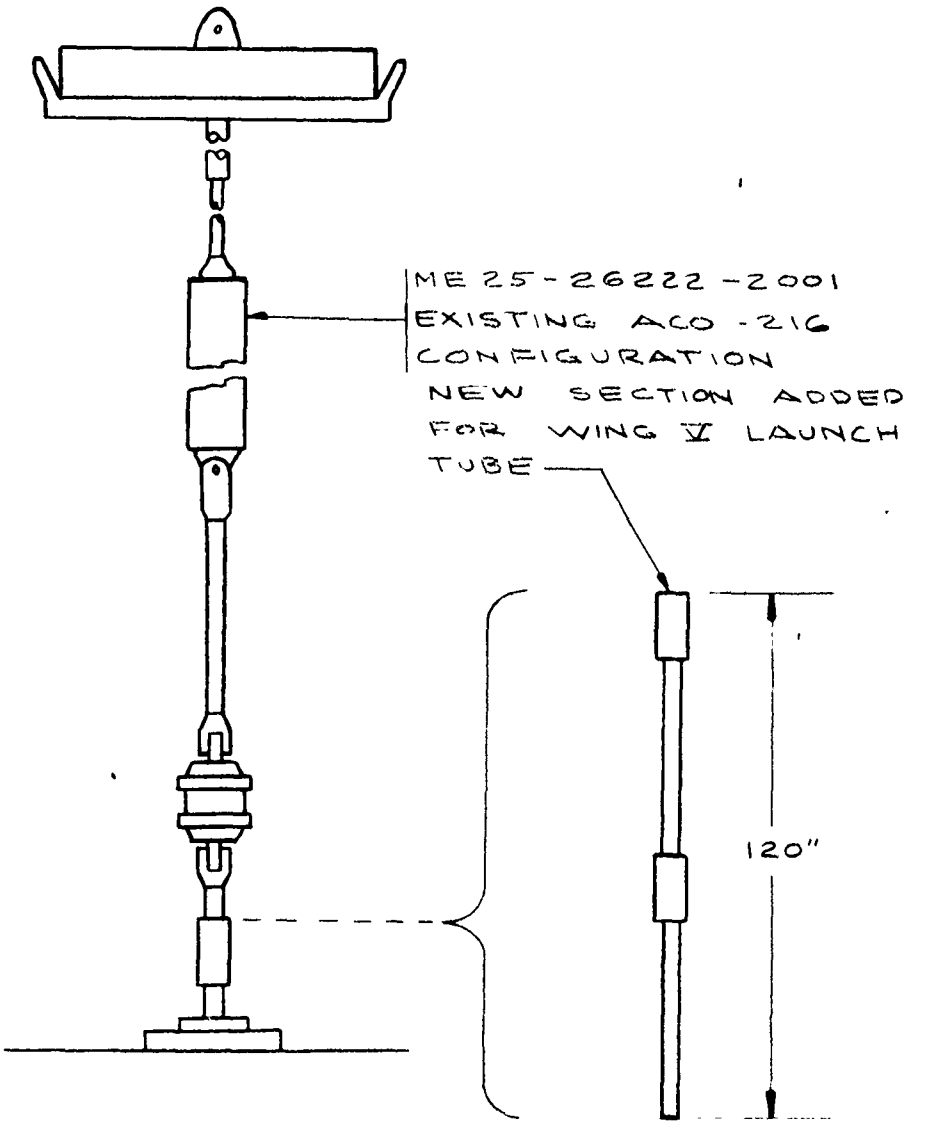

FIG 8.1 -ACO 216 REVISION

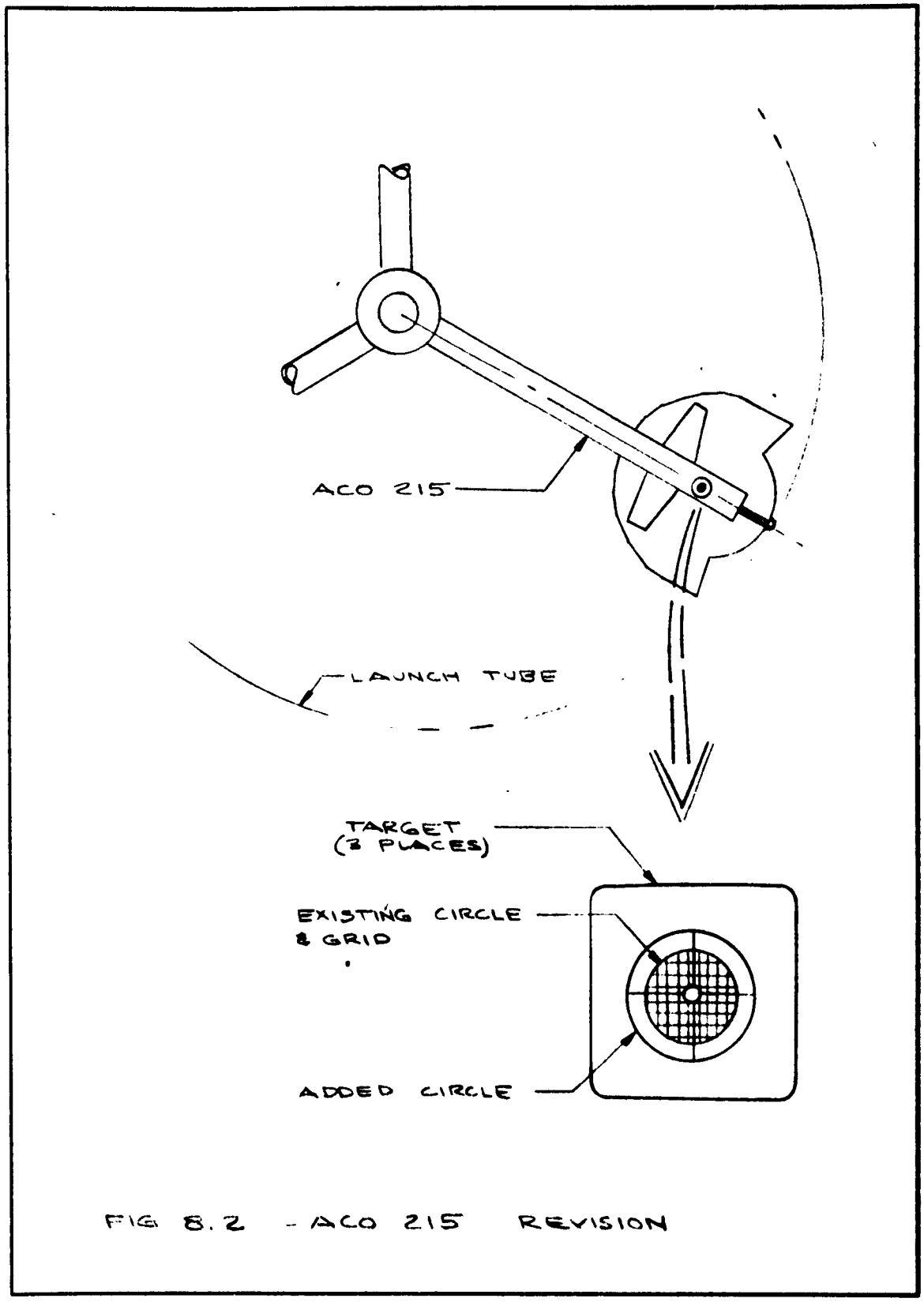

FIG 8.2 - ACO 215 REVISION

9.0 TEST PROGRAM

9.1 Wing V testing will be required. At least one missile launch from a 90 foot deep launcher is recommended. This is necessary to verify the revised missile mount as well as to verify missile fly-out. Preliminary coordination for a Wing V test program has been conducted. (Reference: Telecon Severide/BSD Col. Stuber, 5-21-63).

NOTE: No special testing is authorized at STP III, AMR or VAFB under the scope of this study document and STL Document 6660.42-31 dated 3 January 1963.

9.1.1 The results of this study indicate that no large scale R & D test program is necessary to obtain data on the Wing V changes. It is therefore not necessary to bring STP III or AMR to a "Wing V" configuration solely as a result of the deeper launcher.

9.1.2 Verification testing at VAFB is necessary to demonstrate the validity of the analyses. This test program should consist of one or more firings, with the following specific objectives:

(a) Demonstrate the systems capability and adequacy of the Wing V ten-foot deeper launcher configuration, including facilities, equipment, and technical manuals.

(b) Demonstrate by the successful launch of a missile, that the Wing V configuration launcher does not produce gas dynamic effects deleterious to the missile or mission.

(c) Demonstrate by the successful launch of a missile, that the Wing V configuration of the Support, Missile Suspension, Figure A 1322.5, operates satisfactorily during launch.

(d) Demonstrate that the personnel subsystem including QQPRI, training, technical data, and human engineering can provide the human performance required by the Wing V configuration.

9.2 Launch Facility #7 (0000008) at VAFB is constructed to the Wing V 90-foot depth, however, as shown in Figure 4.1, a steel platform is installed ten feet above the

bottom of the launcher to provide a Wing III configuration. The facility will have to be modified to the Wing V configuration to support testing of the Wing V system.

9.3 The proposed LF #8 at VAFB (See Figure 4.1) would not be available early enough to support Wing V testing. Firings should be scheduled as early in the program as possible to allow time for fixes of any problems that occur.